

Period of Omission of Data during Gear Changes

<Background of Examination>

In validation of HILS, the coefficient of determination varies significantly depending on how we handle the period of omission of data during gear changes. The issues to be addressed are as follows:

1. Difference in the provisions on the period of omission between Kokujikan (No. 281, Chapters 5, Section 6) and gtr draft (A. 9.5.8.1):
 - Kokujikan: data during gear changes (from clutch disengagement to clutch engagement) and for one second before and after gear changes may be omitted.
 - gtr draft: the data during gear change periods may be omitted for this regression analysis, but no more than a period of 2.0 seconds per gear change.
2. The period of omission in Kokujikan ambiguous: It doesn't say which gear changes it talks about: Actual values from valuation test or values from HILS simulated running? In addition, it might be interpreted as referring to gear changes in both tests and one second before and after the change.
3. There are special gear changes that don't fit to Kokujikan's provision.

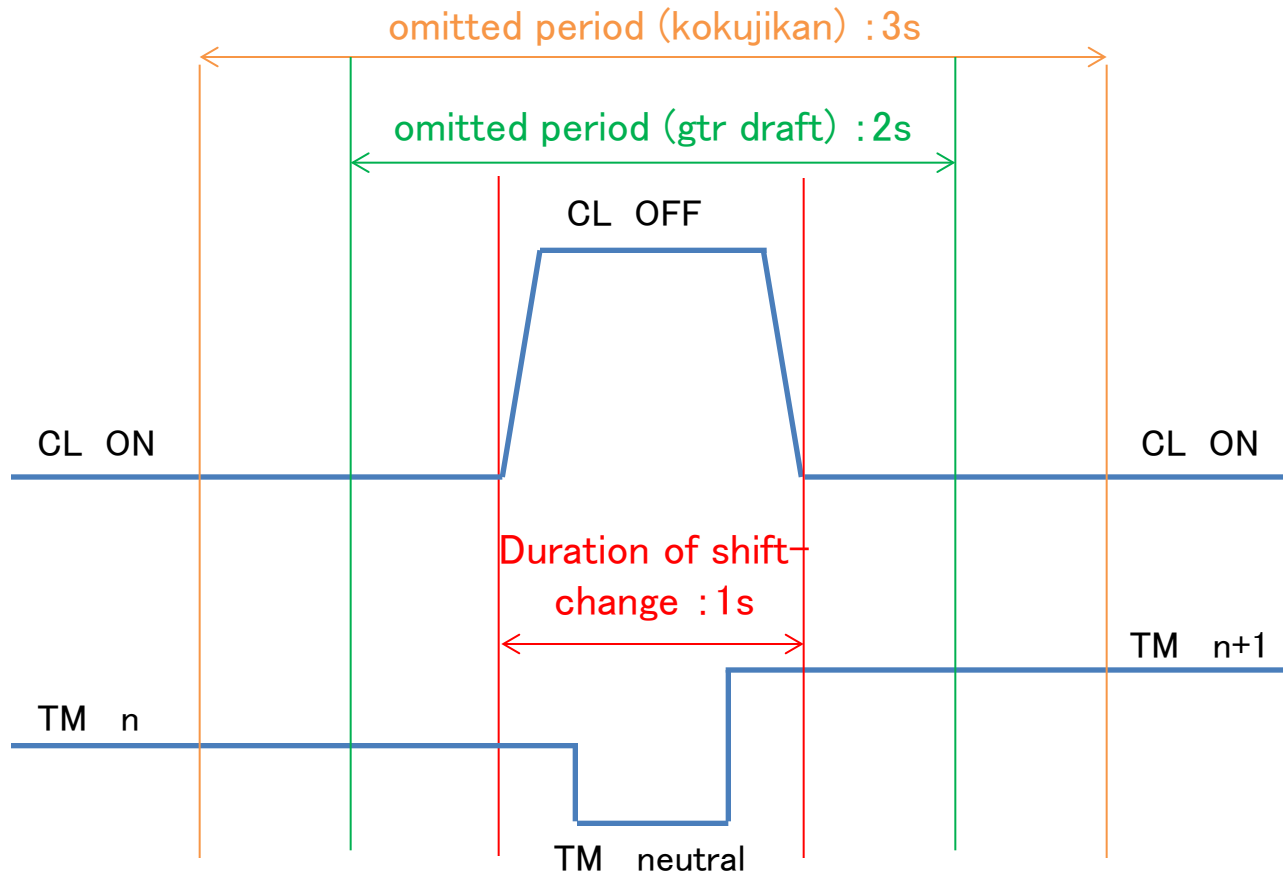


<Objective>

Harmonize Kokujikan and gtr and make gtr a clear, unambiguous provision, not allowing the readers to have different interpretations.

1. Difference in Period of Omission

- Kokujikan defines the period of omission as period “from clutch disengagement to clutch engagement”. If we assume that it takes one second from clutch disengagement to clutch engagement, it follows that the period of omission during gear changes is three seconds.
 - On the other hand, the period of omission in the gtr draft is fixed at two seconds, regardless of how long it actually takes to change gears. This means a severer condition than Kokujikan and is likely to fail the HILS validation.
- => It is appropriate to define the period of omission as the duration of gear changes, plus one second before and after the change.



2. Making the Period of Omission Clear

*** Condition of data omission**

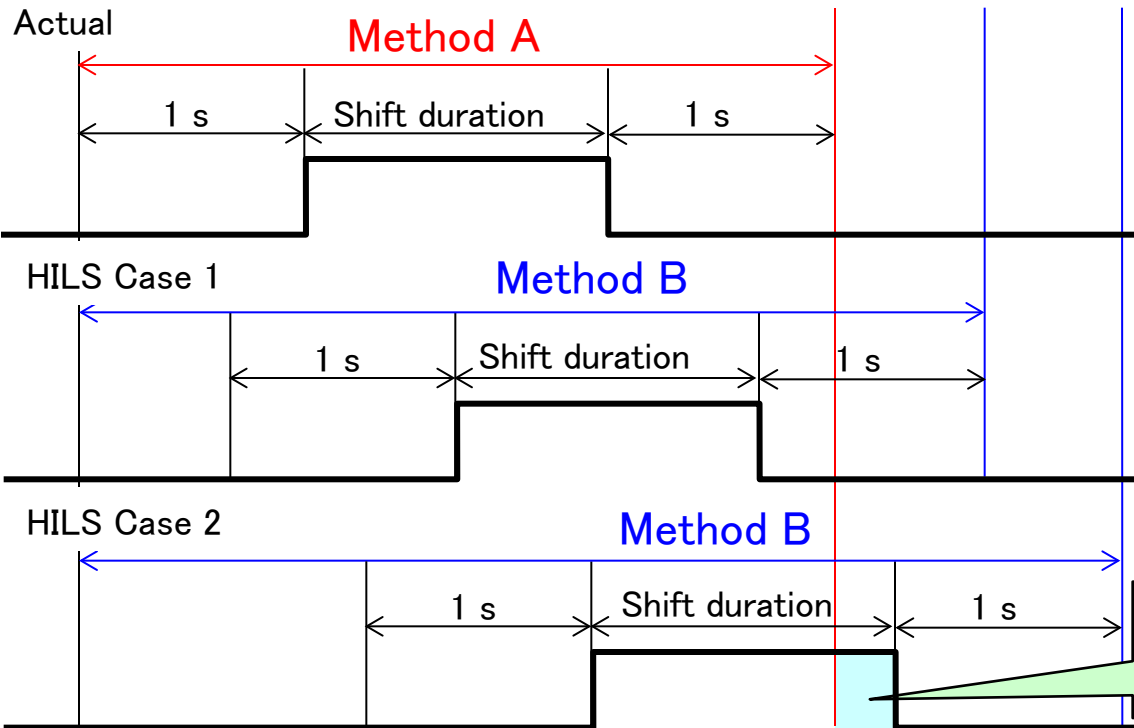
- Method A: Define the period of omission as duration of gear change in the “value actually measured in validation test” or “value in HILS simulated running”, plus one second before and after the change.

- Method B: Define the period of omission as duration of gear change in the “value actually measured in validation test” and “value in HILS simulated running”, plus one second before and after the change.

*** Condition of data**

HILS Case 1: The duration of gear change in the value in HILS simulated running is included in the value actually measured in validation test plus one second before and after the change.

HILS Case 2: The duration of gear change in the value in HILS simulated running is wholly or partly excluded from the value actually measured in validation test plus one second before and after the change.



*** HILS Case 1:**
- There will be no significant difference whether Method A or B is adopted

*** HILS Case 2:**
Method A: Likely to weaken the correlation between the value actually measured in validation test and the value in HILS simulated running.
Method B: Lengthens the period of omission. Reduces the number of specimens for validation (in particular for vehicles with many gears, like those with 12 gears)

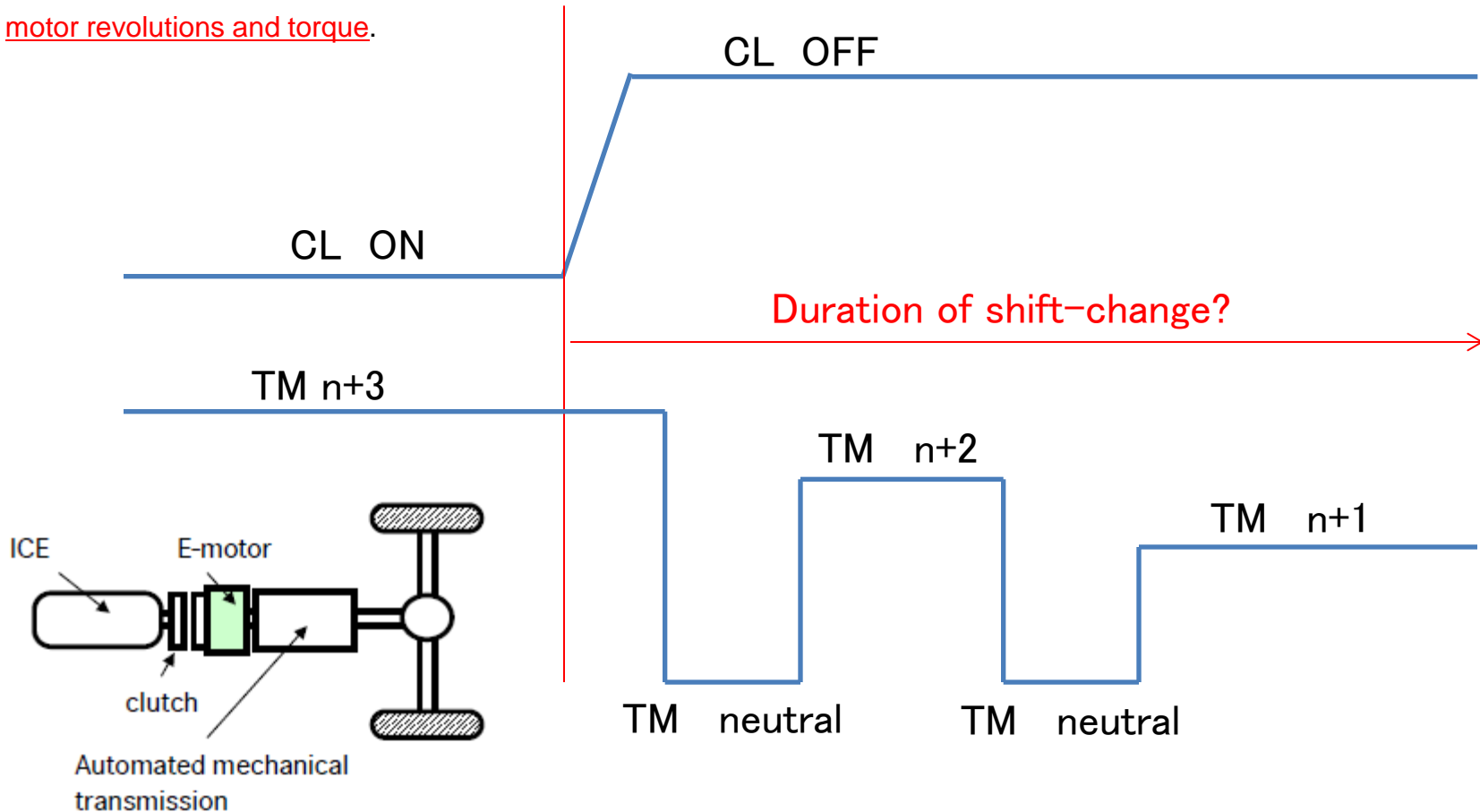
Considering the number of specimens for validation, it is better to adopt Method A.

Engine speed and torque completely differs.

3. Response to Some Particular Gear Change Systems (1)

Among hybrid systems having a clutch between the engine and the motor/generator, some may change gears with the clutch left disengaged while decelerating to increase power regeneration.

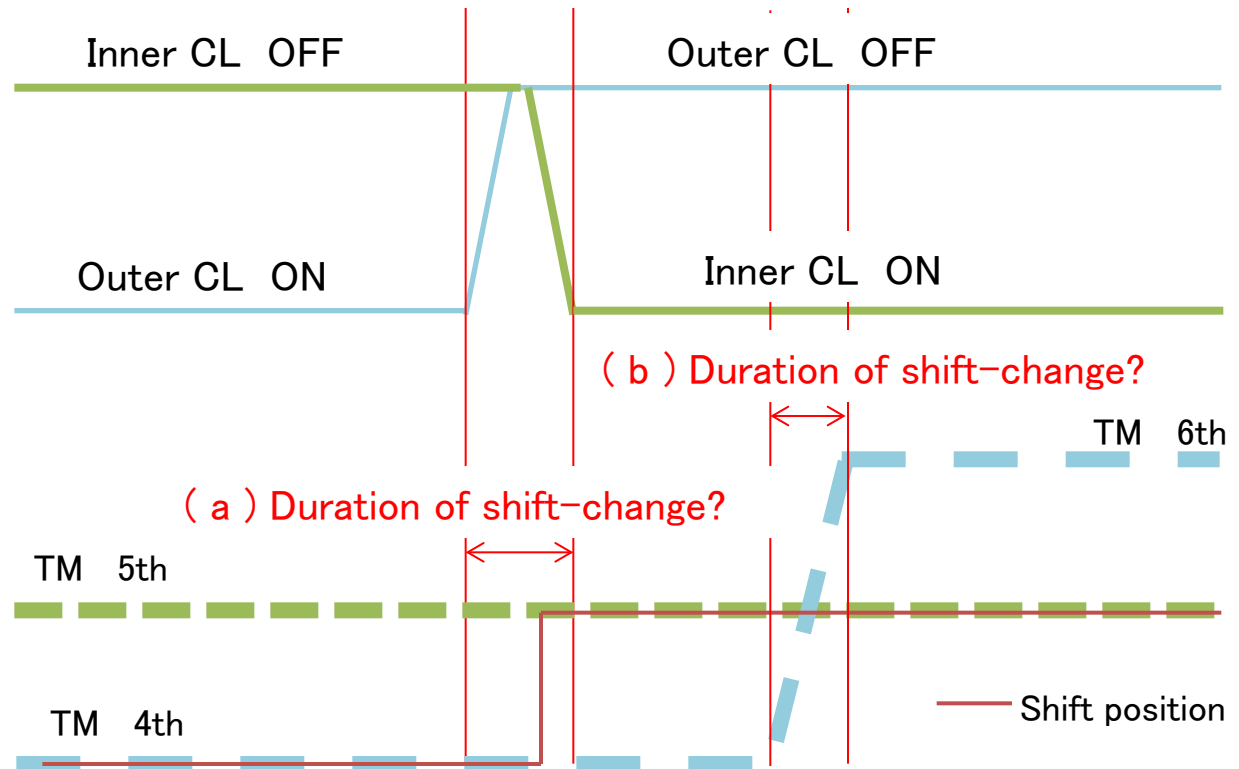
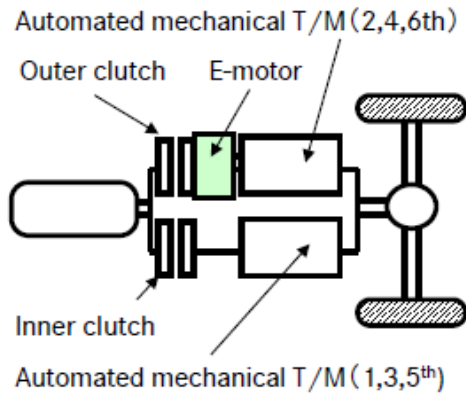
If the gtr defines a gear change as the period “from clutch disengagement to clutch engagement”, it follows that we can omit the whole time the clutch is disengaged. It is not preferable, considering the number of specimen, that the whole time be omitted. On the other hand, gear changes that don't need the disengagement and engagement of the clutch should be included in the period of omission, because, while not influencing the engine revolutions and torque, they do influence the motor revolutions and torque.



3. Response to Some Particular Gear Change Systems (2)

Since HEV with dual-clutch transmission systems have multiple clutches, we need to specify which clutch is the one being considered for the duration of gear change “from clutch disengagement to clutch engagement”. Considering the influence on the engine, it would be better to regard that “the clutch is engaged” if any of the multiple clutches is engaged ((a) in the figure below).

Further, the question arises also as to how we should handle change systems that don't need disengagement and engagement of the clutch ((b) in the figure below). We find it necessary to include them in the period of omission because, while not influencing the engine revolutions and torque, they do influence the motor revolutions and torque.



Summary of Results of Examination

1. The period of omission should be defined as the duration of gear change, plus one second before and after the change.
2. The period of omission should be set based on gear changes in actually measured values (values in HILS simulated running, if the gear change data are not included in the actual values, like those from a system bench method).
3. In cases where the gear change does not accompany either disengagement or engagement of the clutch, or neither of them, it is preferable that one second before and after the change be omitted as appropriate.

Proposed Modification of the gtr Draft

In gtr, the period of omission during gear changes concerns the part underlined of A.9.5.8.1.

A.9.5.8.1. Confirmation of correlation on selected part of the cycle

Correlation between the actually-measured verification values and the HILS simulated running values shall be verified for the selected test cycle part in accordance with paragraph A.9.5.7.2.(a). Table 11 shows the requirements for the tolerance criteria between those values. Here, the data during gear change periods may be omitted for this regression analysis, but no more than a period of 2.0 seconds per gear change.



* We propose modifying the gtr draft as follows:

- (1) Define the period of omission as the duration of gear changes, plus one second before and after the change.
- (2) Rewrite the sentence to the effect that “the data” refers either to actually measured values or values in HILS simulated running.
- (3) Define the gear change periods as follows:
 - a) For gear change systems that need the disengagement and engagement of the crutch, the “duration of gear change” refers to the periods from the disengagement of the crutch to the engagement of the crutch.
 - b) For gear change systems that don’t need the disengagement or engagement of the crutch, the “duration of gear change” refers only to the period from the moment a gear is disengaged to the moment another gear is engaged.

FYI: Definitions of terms in gtr

A.9.5.6. Specific HV model verification input parameters

A.9.5.6.13. Gear change period

The gear-change periods for a manual transmission shall be the actual test values.

A.9.6.2. HEC run input parameters for specific HV model

A.9.6.2.13. Gear change period

The gear-change period for a manual transmission shall be set to one (1.0) second.