Proposal for In-use Data Conversion Technique

(Re-Categorization of in-use data)

proposed by Japan
DHC group
under GRPE/WLTP informal group

version 1 : 22 March 2010

(*) WLTC : Worldwide harmonized Light duty driving Test Cycle

1. Purpose

- It was agreed that each CP has its own unique definition of each road type (urban/rural/motorway) during its 1st DHC meeting. This may lead the discrepancy on speed-acceleration distribution among CPs in same road category.
- This document describes the technique to convert the in-use data into vehicle speed oriented categories.
  - ✓ urban/rural/motorway -> low/middle/high speed
  - ✓ This technique can be used for other re-categorization including more than three (3) divisions

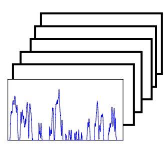
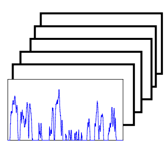
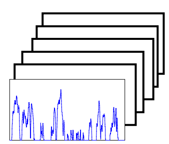
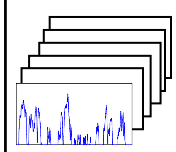
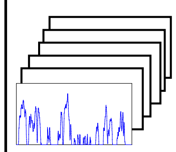
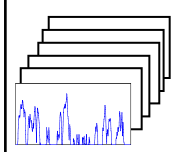
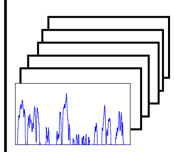
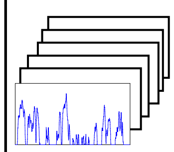
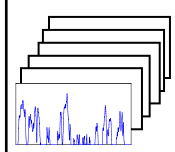
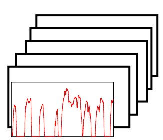
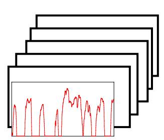
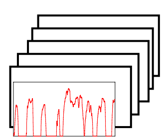
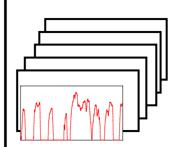
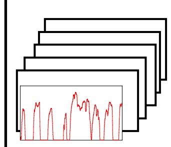
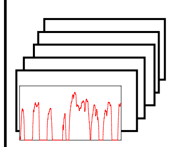
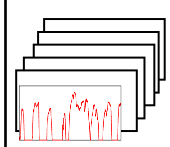
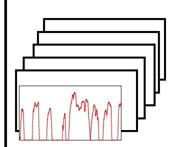
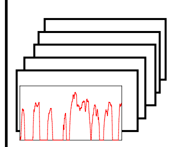
2. Definition of Road Type

	Urban	Rural	Motorway
India	Paved roads in urban areas with a speed limit ≤40 km/hour (exclude mountain areas)	Paved non-motorways outside and inside urban areas with a speed limit between 40 and 60 km/hour	Paved motorways (multi-lane roads specifically constructed and controlled for fast traffic) with a speed 60 to 80 km/hour
Korea	Arterial, collector and local road inside and/or near central business district (CBD). Speed limit is from 40 to 80 km/h, depends on road type	Arterial, collector and local road inside non-urban area. Speed limit is from 50 to 80 km/h, depends on road type	Motorway which is designed, constructed and controlled for faster traffic in urban and rural area. Speed limit is from 100 to 120 km/h, depends on area
Japan	Densely Inhabited District (DID) ・Speed limit≦60km/h ・exclude mountain areas	・Non-Densely Inhabited District ・Non motorways ・exclude mountain areas	Motorways (within City and between Cities) ・exclude mountain areas

3.1. Data analysis process - Step A-1 -

- Categorize the collected data into original matrix with weighting factor
  - < Matrix : road type/vehicle category/time period >
- Record the collected data duration in each matrix

➢Collected data set

Road type / Vehicle category	Urban			Rural			Motorway		
	Weekday		Week-end	Weekday		Week-end	Weekday		Week-end
	On-peak	Off-peak		On-peak	Off-peak		On-peak	Off-peak	
Passenger Car									
Light Duty Commercial Vehicle									

3.1. Data analysis process - Step A-2 -

➢Weighting factor matrix

road		vehicle		congestion	
urban	w_U	PC	$w_{U,PC}$	on peak	$w_{U,PC,ON}$
				off peak	$w_{U,PC,OFF}$
				weekend	$w_{U,PC,E}$
		LCV	$w_{U,LCV}$	on peak	$w_{U,LCV,ON}$
				off peak	$w_{U,LCV,OFF}$
				weekend	$w_{U,LCV,E}$
rural	w_R	PC	$w_{R,PC}$	on peak	$w_{R,PC,ON}$
				off peak	$w_{R,PC,OFF}$
				weekend	$w_{R,PC,E}$
		LCV	$w_{R,LCV}$	on peak	$w_{R,LCV,ON}$
				off peak	$w_{R,LCV,OFF}$
				weekend	$w_{R,LCV,E}$
motorway	w_M	PC	$w_{M,PC}$	on peak	$w_{M,PC,ON}$
				off peak	$w_{M,PC,OFF}$
				weekend	$w_{M,PC,E}$
		LCV	$w_{M,LCV}$	on peak	$w_{M,LCV,ON}$
				off peak	$w_{M,LCV,OFF}$
				weekend	$w_{M,LCV,E}$
sum	1	sum	1	sum	1

➢The collected data duration

road		vehicle		congestion	
urban	T_U	PC	$T_{U,PC}$	on peak	$T_{U,PC,ON}$
				off peak	$T_{U,PC,OFF}$
				weekend	$T_{U,PC,E}$
		LCV	$T_{U,LCV}$	on peak	$T_{U,LCV,ON}$
				off peak	$T_{U,LCV,OFF}$
				weekend	$T_{U,LCV,E}$
rural	T_R	PC	$T_{R,PC}$	on peak	$T_{R,PC,ON}$
				off peak	$T_{R,PC,OFF}$
				weekend	$T_{R,PC,E}$
		LCV	$T_{R,LCV}$	on peak	$T_{R,LCV,ON}$
				off peak	$T_{R,LCV,OFF}$
				weekend	$T_{R,LCV,E}$
motorway	T_M	PC	$T_{M,PC}$	on peak	$T_{M,PC,ON}$
				off peak	$T_{M,PC,OFF}$
				weekend	$T_{M,PC,E}$
		LCV	$T_{M,LCV}$	on peak	$T_{M,LCV,ON}$
				off peak	$T_{M,LCV,OFF}$
				weekend	$T_{M,LCV,E}$

It is expected that the collected data volume in each matrix doesn’t match the weighting factor obtained based on vehicle statistical information.

3.2. Data analysis process - Step B -

- Need to compensate the weighting factor of each matrix since the specific short trip is possible to move into different matrix.

(1) Calculate the compensated weighting factor (w_i')

road		vehicle		congestion	
urban	w_U	PC	$w_{U,PC}$	on peak	$w_{U,PC,ON}'$
				off peak	$w_{U,PC,OFF}'$
				weekend	$w_{U,PC,E}'$
		LCV	$w_{U,LCV}$	on peak	$w_{U,LCV,ON}'$
				off peak	$w_{U,LCV,OFF}'$
				weekend	$w_{U,LCV,E}'$
rural	w_R	PC	$w_{R,PC}$	on peak	$w_{R,PC,ON}'$
				off peak	$w_{R,PC,OFF}'$
				weekend	$w_{R,PC,E}'$
		LCV	$w_{R,LCV}$	on peak	$w_{R,LCV,ON}'$
				off peak	$w_{R,LCV,OFF}'$
				weekend	$w_{R,LCV,E}'$
motorway	w_M	PC	$w_{M,PC}$	on peak	$w_{M,PC,ON}'$
				off peak	$w_{M,PC,OFF}'$
				weekend	$w_{M,PC,E}'$
		LCV	$w_{M,LCV}$	on peak	$w_{M,LCV,ON}'$
				off peak	$w_{M,LCV,OFF}'$
				weekend	$w_{M,LCV,E}'$
sum	1	sum	1	sum	1

$$W_{U,PC,ON}' = \frac{W_{U,PC,ON}}{T_{U,PC,ON}} \times A_{U,PC}$$

$$W_{U,PC,OFF}' = \frac{W_{U,PC,OFF}}{T_{U,PC,OFF}} \times A_{U,PC}$$

$$W_{U,PC,E}' = \frac{W_{U,PC,E}}{T_{U,PC,E}} \times A_{U,PC}$$

where

$$A_{U,PC} = \frac{W_{U,PC,ON} + W_{U,PC,OFF} + W_{U,PC,E}}{\frac{W_{U,PC,ON}}{T_{U,PC,ON}} + \frac{W_{U,PC,OFF}}{T_{U,PC,OFF}} + \frac{W_{U,PC,E}}{T_{U,PC,E}}}$$

Same equation will be applied to others

3.3. Data analysis process - Step C-1 -

- Convert the each short trip data including the previous idling portion into new categories (Low/Middle/High) from original (Urban/Rural/Motorway) categories with the compensated WF (w')

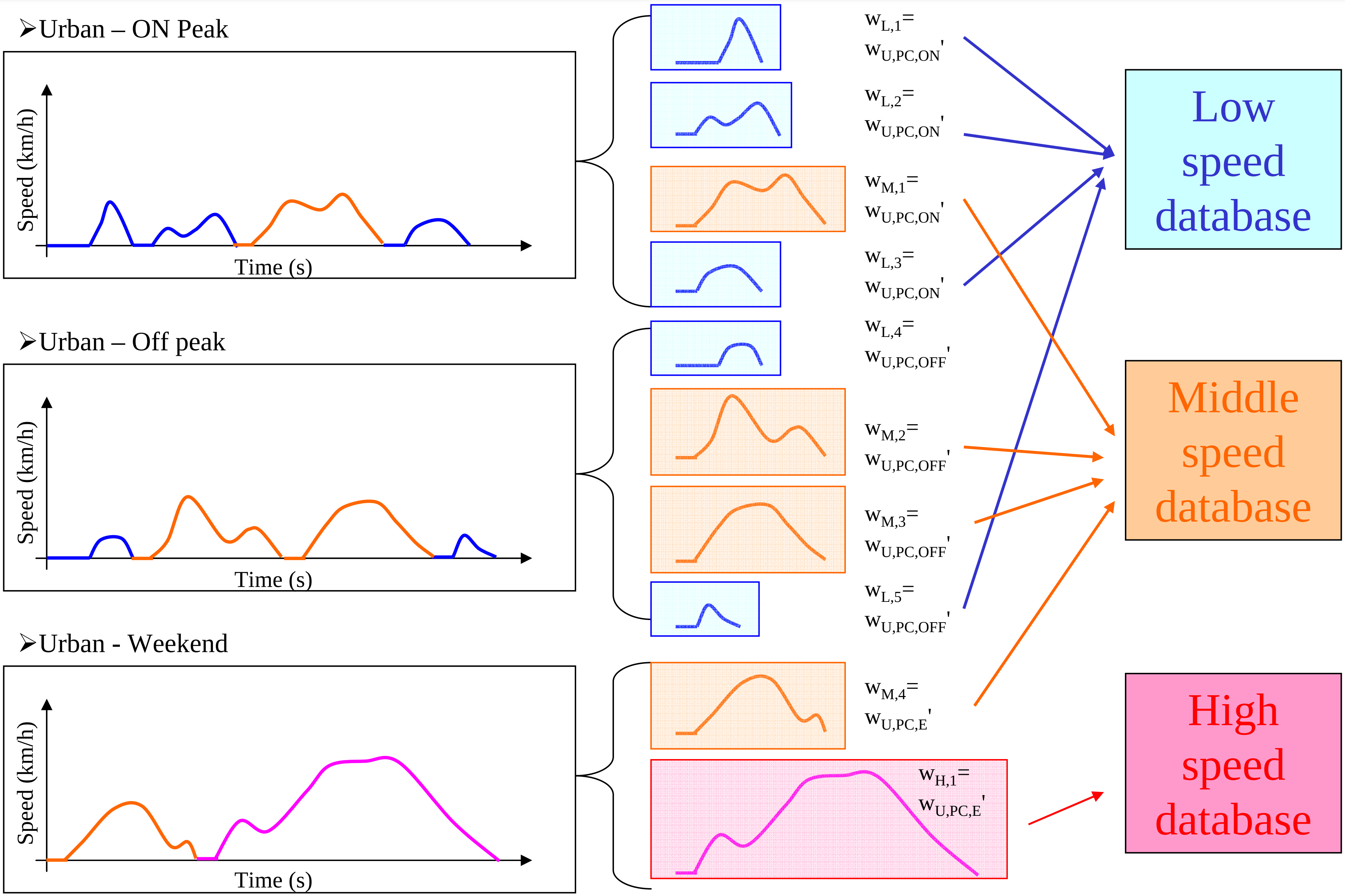
  criteria : maximum vehicle speed of each short trip

Proposed Criteria:

Phase	Max. speed of each ST
Low speed	~ 40* km/h
Middle speed	40* ~ 80* km/h
High speed	80* km/h ~

*) the specific vehicle speed subject to change based on the collected data.

3.3. Data analysis process - Step C-2 -



（修正版）3-4. Data analysis process - Step D -

- The collected data was converted into new categories.

New weighting factors（w_L, w_M, w_H） are calculated as follows.

$$w_L = \frac{\sum_i (w_{L,i} \times T_{L,i})}{\sum_i (w_{L,i} \times T_{L,i}) + \sum_i (w_{M,i} \times T_{M,i}) + \sum_i (w_{H,i} \times T_{H,i})}$$

$$w_M = \frac{\sum_i (w_{M,i} \times T_{M,i})}{\sum_i (w_{L,i} \times T_{L,i}) + \sum_i (w_{M,i} \times T_{M,i}) + \sum_i (w_{H,i} \times T_{H,i})}$$

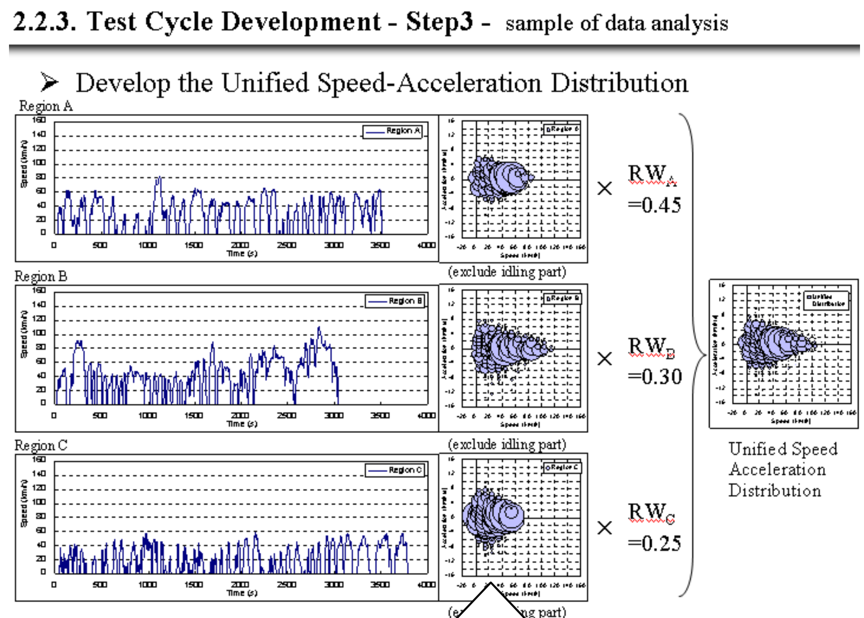
$$w_H = \frac{\sum_i (w_{H,i} \times T_{H,i})}{\sum_i (w_{L,i} \times T_{L,i}) + \sum_i (w_{M,i} \times T_{M,i}) + \sum_i (w_{H,i} \times T_{H,i})}$$

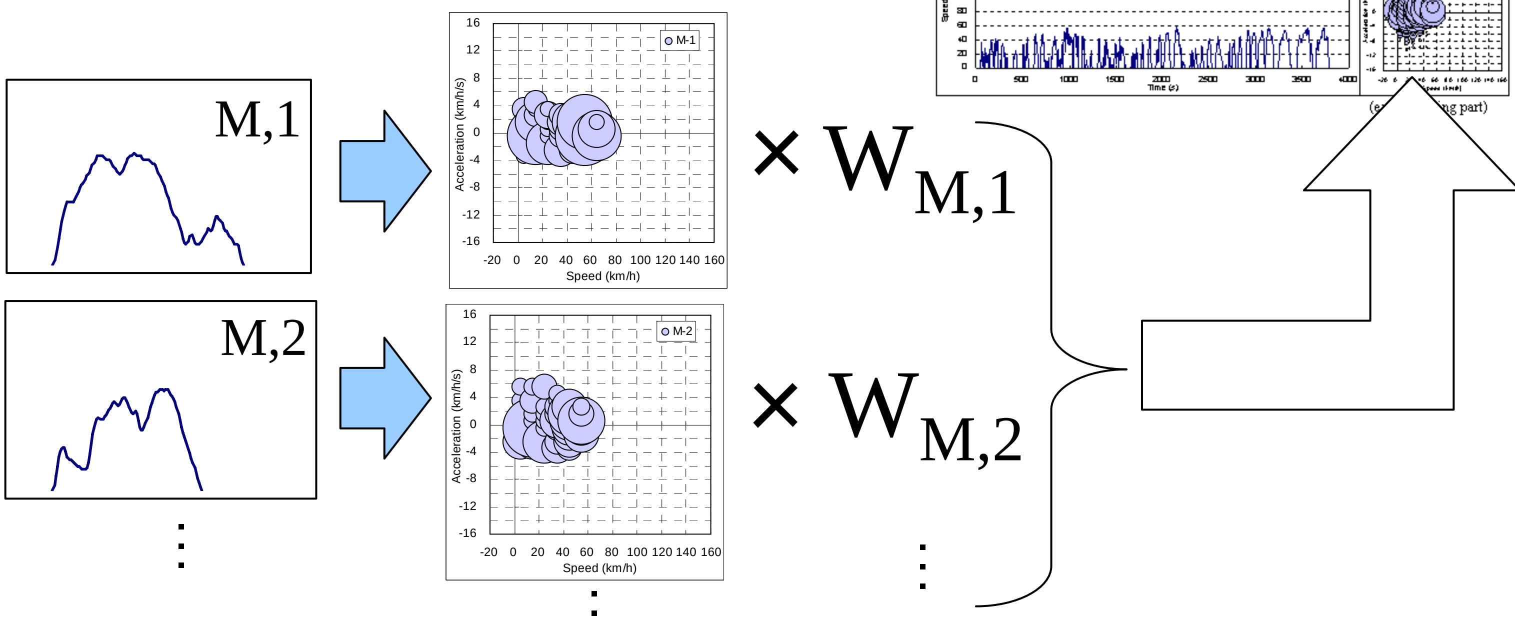
- This process will be done in each data collection CPs.
- Then, move on to

“2.2.3. Test Cycle Development - Step3 – in WLTP-DHC-02-04” with slight modification.

3.5. Data analysis process – Modification 1 -

- Speed-Acceleration distribution of each short trip should be multiplied by the compensated weighting factors (w’).



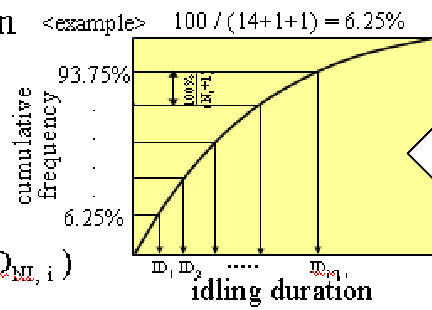


3.5. Data analysis process – Modification 2 -

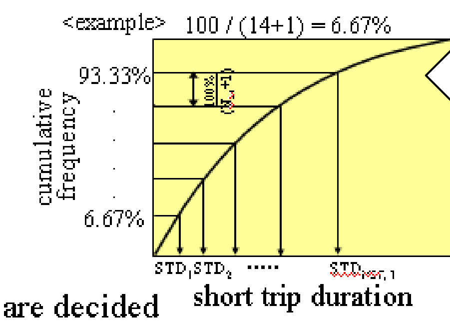
- Frequency distribution for idling & short trip duration also should be multiplied by the compensated weighting factors (w').

2.2.5. Test Cycle Development - Step5 -

- Determine the $N_{I,\,i}$ units of idling duration in each phase
  - ✓ Generate the cumulative frequency graph based on idling data base
  - ✓ Divide into ($N_{I,\,i}$+1) equally in Y axis
  - ✓ $N_{I,\,i}$ units of idling duration (ID_1, ID_2, ..., $ID_{NI,\,i}$) in each phase are decided



- Determine the $N_{ST,\,i}$ units of short trip duration in each phase
  - ✓ Generate the cumulative frequency graph based on short trip data base
  - ✓ Divide into ($N_{ST,\,i}$+1) equally in Y axis
  - ✓ $N_{ST,\,i}$ units of short trip duration (STD_1, STD_2,..... , $STD_{NST,\,i}$) in each phase are decided
  - ✓ Pick the candidate short trips which duration are STD_1, STD_2, ..., $STD_{NST,\,i}$



Vertical Axis :

Number of data
×
the compensated weighting factor

3.6. Data analysis process

- Then move on to

"2.2.6. Test Cycle Development – Step6 – in WLTP-DHC-02-04" with no more modification.