WLTP DHC subgroup	
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1.0. Introduction

These guidelines were developed and agreed following a full discussion at the 1st DHC meeting held in September 2009. A brief review of previous in-use data collection exercises is provided for reference and detailed guidelines for in-use data collection are presented.

A presentation (WLTP-DHC-02-04) accompanies this paper. Templates that should be used when submitting in-use data will be circulated to Contracting Parties shortly.

2.0. Previous studies

In developing these draft guidelines, it was appropriate to review previous studies that have sought to develop new drive cycles. The worldwide harmonized motorcycle emissions certification procedure (WMTC) and the worldwide heavy duty certification procedure (WHDC) have recently produced two new drive cycles; the in-use data collection activities associated with these test procedures are summarised below.

2.1. WHDC

Data were collected from a total of 65 vehicles covering a range of heavy duty vehicles classified by gross vehicle weight (GVW). In-use data were collected from three global regions: EU, USA, Japan. Over 744, 000 km of data were collected over a range of road types (urban, rural and motorway).

More information on WHDC can be found at:

http://www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29registry/gtr4.html

http://www.unece.org/trans/main/wp29/wp29wgs/wp29grpe/whdc_docs.html

http://www.unece.org/trans/doc/2001/wp29grpe/TRANS-WP29-GRPE-42-inf02.pdf

2.2. WMTC

In-use data were collected from four global regions: EU, USA, Japan and China, with most data originating from the EU. Data were collected from a total of 40 motorcycles covering a range of vehicles (engine capacity, power-to-mass ratio, manufacturer, etc). Over 27, 000 km of data were collected, corresponding to a total collection of 518 driving hours.

Three different road types were included in the data collection; however, difficulty was experienced when comparing use on different road types as the definitions from different regions were not always compatible. During data analysis, it was necessary to redefine road types according to defined speed distributions for each road type.

More information on WMTC can be found at:

http://www.unece.org/trans/main/wp29/wp29wgs/wp29gen/wp29registry/ECE-TRANS-180a2app1e.pdf

3.0. Overview of data collection

A number of different parameters must be considered when deciding what data to collect during the in-use data collection exercise and when developing guidelines for the collection of these data. It is necessary to consider a range of parameters, including (but not limited to):

- Regions from which data will be collected
- Categories of vehicles
- Driving conditions
- Road type
- Volume of data
- Type of data to be measured.

This section provides guidelines that should be adhered to when collecting in-use data that will feed into the development of the WLTC.

3.1. Regions

Data will be collected from the following regions:

- China
- EU
- India
- Japan
- South America (FIA)
- South Korea
- USA

3.2. Vehicle selection

In-use data should be collected from a range of light duty vehicles. Table 3.1 summarises definitions of light duty vehicles (gross vehicle weight < 3.5 tonnes) set down in Special Resolution No. 1 concerning the common definitions of vehicle categories, masses and dimensions.

Table 3.1. S.R. 1 Vehicle categories

Category	Description	Gross vehicle weight/mass
1-1	Power driven vehicle with four or more wheels comprising not more than 8 seating positions in addition to the driver's seating position. Cannot have standing passengers	< 3.5 T
1-2	Power driven vehicle with four or more wheels designed for the carriage of more than 8 passengers, whether seated or standing, in addition to the driver	< 3.5 T
2	Power driven vehicle with four or more wheels designed and constructed primarily for the carriage of goods	< 3.5 T

At the 1st DHC group it was decided that Contracting Parties should collect data from as wide a range of vehicle categories as possible and that data collection from vehicles classified as "medium duty passenger vehicles" under US legislation (e.g. Hummers) would also be considered during the data analysis. For the purposes of data collection, vehicles will be categorised into passenger vehicles and light duty commercial vehicles. It was agreed that Contracting Parties should record vehicle parameters (see following section) when collecting in-use data, so that data can be subcategorised during data analysis, if required.

3.2.1. Vehicle parameters

In addition to classifying vehicles in terms of category, it is also desirable to consider other distinguishing parameters such as power-to-mass ratio, engine swept volume, gross vehicle weight, etc. Table 3.2 lists those vehicle parameters that must be recorded when collecting in-use data.

Table 3.2. Vehicle parameters

Parameter	Example
Vehicle category	Passenger car/Light duty commercial vehicle
	S.R. 1 category (1-1, 1-2, 2)
Engine type	Diesel/Gasoline/LPG
Engine displacement	2 L
Curb mass (kg)	1600 kg
Transmission type	Manual/Automatic
Number of gears	4/5/6
Power:Mass	0.05 kW/kg
Maximum rated power	80 kW
Maximum rated speed	130 km/hour
Number of passengers	5
Maximum load	500 kg
Year model first registered	2006
Make[1]	*Ford*
Model[1]	*Focus*
GSI[1]	*Yes/No*
Adaptive speed limit indicator[1]	*Yes/No*

[1] Optional — it is recommended that these parameters are recorded

Contracting parties should ensure that the range of vehicles selected for in-use data collection encompasses as wide a range as possible of the vehicle parameters listed in table 3.2 and that the vehicles selected are representative of the market mix in each region.

3.2.2. Vehicle conditions

In order to ensure collection of comparable data, it will be necessary to establish standard vehicle conditions. Vehicle conditions such as laden weight will affect driving patterns and gearshift points. It is also important to consider the time between starting the engine and driving off as this will affect catalyst light off time.

The load state of vehicles used for data gathering is not prescribed; however, Contracting Parties should ensure that load state is recorded.

Contracting Parties should ensure that data is collected from engine key-on (i.e. cold start).

3.3. Driving conditions

Driving conditions will affect vehicle/engine speed and thus will need to be considered when undertaking the in-use data collection exercise. Factors such as driving behaviour, road type, season/weather conditions, time of day/week and vehicle conditions should all be considered.

3.3.1. Driving behaviour

Collected data should be representative of normal driving behaviour to ensure that a representative drive cycle is developed. Drivers should be instructed to follow the traffic flow. For vehicles fitted with gear shift indicators, drivers should be instructed to drive as they wish (i.e. they should not be instructed to follow the gear shift indicator).

3.3.2. Driver selection

Gender, age and experience will all affect behaviour. However, it is not the objective of DHC to investigate these effects. Instead, it is proposed that Contracting Parties ensure as wide a range of drivers are used when collecting in-use data. Table 3.3 details the different driver parameters that should be recorded when collecting in-use data. The additional data gathered from recording these parameters may be used to assess spurious data points during data analysis.

Table 3.3. Driver parameters

Driver parameter	Example
Driver gender	Male/Female
Drive age	25
Does driver pay for fuel	Yes/No

3.3.3. Road type

A review of previous studies revealed some of the problems associated with defining road types on a global basis. Table 3.4 summarises the road type definitions used in previous studies and suggested definitions to be used in WLTP.

At the 1st DHC meeting it was agreed that Contracting Parties should be free to use their own definitions of road type in their regions for the purposes of data gathering if they wish, rather than using the WLTP recommendation. It is important that Contracting Parties use the same definitions for collecting in-use data and determining weighting factors (see WLTP-DHC-02-05. Contracting Parties should submit a report with their in-use data detailing their regional definitions of road type and driving period. Where possible, photographic/videographic evidence of roads should be provided in this report.

Table 3.4. Road type definitions

	Urban	Rural	Motorway
WHDC[1]	Roads in urban areas with speed limit of 50 km/hour or lower	Non-motorways outside and inside urban areas with a speed limit between 50 and 80 km/hour	Roads specially constructed and controlled for fast traffic (in most cases with more than 2 lanes), with the maximum speed limit allowed in that region
WMTC[2]	Vehicle speed: Between 0 and 60 km/hour ≥ 80 % of the time 90 km/hour = 0 % time Maximum speed ≤ 80 km/hour	Vehicle speed: Between 0 and 60 km/hour ≤ 70% of the time Between 60 and 90 km/hour ≥ 30% of the time 90 km/hour ≤ 50% of the time Maximum speed ≤110 km/hour	Vehicle speed: Between 0 and 60 km/hour ≤ 20 % of the time 90+ km/hour ≥ 50 % of the time
Suggested WLTP[3]	Paved roads in urban areas with a speed limit ≤50 km/hour (exclude mountain areas)	Paved non-motorways outside and inside urban areas with a speed limit between 50 and 100 km/hour (exclude mountain areas)	Paved motorways (multi-lane roads specifically constructed and controlled for fast traffic)

[1]Road type definitions were based on road types

[2]Road type definitions were based on collected data

[3]Suggested definitions for WLTP; note that Contracting Parties should define the road type definitions in their region.

3.3.4. Season/weather conditions

Ideally, it would be desirable for data to be collected during the same season and under similar weather conditions. However, owing to the tight timeline for development of the drive cycle, it will be necessary for all data collection to occur over the same period of time, thus occurring during different seasons depending on the geographic location of the region.

Contracting Parties are urged to collect data under safe conditions and to avoid situations of low visibility such as heavy rain, fog and snow. However, it is recognised that such weather conditions may be common in certain Contracting Parties and as such Contracting Parties have discretion to collect data in adverse weather conditions providing that details of such conditions are recorded on the data proforma.

3.3.5. Time of data collection

In order to ensure that the final drive cycle is as representative as possible it is desirable to collect in-use data over all possible periods of driving, i.e., peak hours (rush hour traffic) and off-peak. Contracting Parties should define the different driving periods in their region and ensure that data are collected across a range of these periods. As per road type, Contracting Parties should submit details of their definitions of driving periods with their in-use data and should ensure that the same definitions are applied when determining the associated weighting factors.

3.4. Amount of data to be collected

Taking into account sections 3.1 – 3.3, which discuss the various parameters that need to be considered during in-use data collection, it is possible to propose a data collection matrix (see table 3.5). Parameters are categorised as driving or vehicle parameters. Following the data collection requirements outlined in sections 3.1 to 3.3, there are 162 possible combinations of driving parameters. In order to keep data collection manageable, it is proposed to use a minimum of 12 test vehicles for data collection in each region. These vehicles should be selected according to the vehicle parameters set out in Table 3.2 to ensure that a suitable range of vehicles of different categories and types is used. Assuming that a minimum of 12 test vehicles will be used in each region, 1944 sets of in-use data will be collected and used to develop the drive cycle.

In developing guidelines for in-use data collection it is necessary to prescribe how much in-use data should be collected. This can be done in one of two ways: setting a minimum drive time for data collection (i.e. *x* hours per vehicle, or setting a minimum drive distance for data collection (i.e. *y* km). During data collection for WHDC the average drive distance per vehicle/road type/region combination was 2067 km. For WMTC this distance was lower at 756 km. While it is desirable to collect as much data as possible, data collection must be balance with what is practically achievable.

For WLTC we recommend a minimum of 1000 km per vehicle category/transmission/road type/region combination.

Table 3.5. Data collection matrix

	Driving parameters				**Vehicle parameters**			
	Region	**Road type**	**Driving period**	**Driver age**	**Vehicle category**	**Vehicle parameter**	**Power to mass ratio**	**Transmission**
Parameters	China EU India Japan South America South Korea USA	Urban Rural Motorway	Peak Off-peak (week) Off-peak (weekend)	Range of diver ages	Car Light duty commercial vehicle	GVW Engine swept volume Drive train Body type etc	Low Normal High?	Automatic Manual (4) Manual (5) Manual (6)
Number of parameters to be varied	7	3	3		Minimum of 12 test vehicles per region			

3.5. Data to be collected

Before starting the in-use data collection exercise it is important to determine exactly which data will be monitored and how these will be collected. Table 3.6 details the proposed minimum requirements for data monitoring on a continuous basis.

Table 3.6. Continuous data to be monitored

Data	Mandatory	Minimum sampling frequency	Measurement methods
Time	Yes	1 Hz	
Vehicle speed	Yes	1 Hz	• ECU • GPS speed meter • Calculate from drive shaft speed • Non-contact vehicle speed meter • Additional wheel
Engine speed	Yes for manual transmission Recommended for automatic transmission	1 Hz	• ECU • Photoelectric pick-up • Ignition pulsation • Accelerometer
Road gradient (altitude)	Recommended	1 Hz	• GPS + pressure sensor
Clutch actuation	Recommended	1 Hz	• ECU • Assume from engine speed • Clutch depression switch

3.6. Existing data

Existing/historical data may be submitted for consideration in development of the WLTC. These data should meet the minimum requirements set out in this guideline document. A comparison of existing/historical and new data will be made to ensure that existing/historical data does not differ significantly from newly collected data. This comparison will be made through analysis of unified distributions.

Existing/historical data that does not include engine speed data may be considered in developing the drive cycle, but will not be considered for gear shift analysis.

4.0. Data format

Raw data should be submitted in comma separated format (csv).

A document will be circulated to Contracting Parties detailing the format that must be followed when submitting data for consideration.

In addition to the raw data, a file proforma should be completed. This proforma contains details such as vehicle and parameters. This proforma is still under development.