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WORLDWIDE HARMONIZED MOTORCYCLE EMISSIONS CERTIFICATION PROCEDURE (WMTC)

TECHNICAL REPORT

Transmitted by the expert from Germany

Note: The document reproduced below has been transmitted by the expert from Germany on behalf of the informal group developing the worldwide-harmonized motorcycle emissions certification procedure (WMTC).

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1. INTRODUCTION

At its beginning (1999), the development of the Worldwide-harmonized Motorcycle Test Cycle (WMTC) was a tripartite project between the Netherlands Ministry of the Environment (VROM), TNO Automotive and the International Motorcycle Manufacturer Association (IMMA). Within this tripartite project, VROM looked after the political aspects of generating a worldwide test cycle. TNO Automotive, funded by VROM, did the development work and the technical management of the project. IMMA contributed by the collection of in-use driving behaviour data worldwide.

In a later stage (May 2000), the project was brought under the umbrella of the UNECE/WP.29. Under the guidance of WP.29, the Group of Experts on Pollution and Energy (GRPE) mandated the ad-hoc group WMTC with the development of a "**W**orld-wide Harmonized **M**otorcycle Emissions Certification/**T**est Pro**C**edure" and to establish it in the framework of the 1998 Agreement on global technical regulations (gtr). Since October 2000, RWTUEV Fahrzeug GmbH joined the WMTC group. RWTUEV Fahrzeug developed a gearshift procedure closely linked to the test cycle. This work was funded by the German Bundesanstalt für Straßenwesen (BASt). Since May 2001, RWTUEV Fahrzeug got the responsibility for the cycle development work, the development of the test protocol and the coordination of the validation programme by order of the Netherlands Ministry of the Environment (VROM) and with support by the German Federal Ministry of Transport, Building and Housing (BMVBW).

The WMTC group was formed by members of the following countries/organisations:

- European Commission,
  - Directorate General Enterprise (DG ENTR),
  - Joint Research Centre (JRC).
- Germany,
  - Federal Ministry of Transport, Building and Housing (BMVBW),
  - Federal Highway Research Institute (BASt),
  - RWTUEV Fahrzeug GmbH, institute for vehicle technology,
  - TÜV NORD Straßenverkehr GmbH.
- Italy,
  - Ministry of Infrastructure and Transport (MoT).
- Japan,
  - Ministry of Land, Infrastructure and Transport (former Ministry of Transport),
  - Ministry of Environment (former Environment Agency),
  - National Traffic Safety and Environment Laboratory (NTSEL),
  - Japan Automobile Research Institute (JARI),
  - Japan Automobile Standards Internationalization Center (JASIC).
- Netherlands,
  - Netherlands Ministry of the Environment (VROM),
  - TNO Automotive, Delft.
- Spain,
  - National Institute of Aerospace Technique (INTA).

- Switzerland,
  - Swiss Federal Roads Authority (ASTRA), Bern,
  - Swiss Federal Laboratories for Materials Testing and Research (EMPA), Dubendorf,
  - University of Applied Sciences, Lab. for Exhaust Emission Control (HTA), Biel.
- United Kingdom,
  - Department of Transport,
  - Ricardo Ltd.
- United States of America (USA),
  - US Environmental Protection Agency.
- Association for Emissions Control by Catalyst (AECC).
- Federation of European Motorcyclists Association (FEMA).
- International Motorcycle Manufacturers Association (IMMA).

With respect to the tight timeframe of the work and in order to increase the efficiency the WMTC group established a subgroup of experts that met more frequently than the WMTC group and prepared all necessary material for the discussions and decisions in the WMTC group. This subgroup was called WMTC FE (fundamental elements).

2. OBJECTIVE

The objective of the research program is to develop a worldwide-harmonized motorcycle emissions test procedure, consisting of:

- a test cycle,
- a gearshift procedure,
- sampling, measurement and analysis procedures (with support from/in collaboration with ISO)

The test procedure needs to be:

- representative of world-wide on-road vehicle operation,
- able to provide the highest possible level of efficiency in controlling on-road emissions,
- corresponding to state-of-the-art testing, sampling and measurement technology,
- applicable in practice to existing and foreseeable future exhaust emissions abatement technologies,
- capable of providing a reliable ranking of exhaust emission levels from different engine types,
- consistent with the development of appropriate emission factors,
- inclusive of adequate cycle-bypass prevention provisions.

The test procedure has to cover the cycle and the accompanying gearshift procedure for the test bench measurements and the prescription of test bench settings like determination of road load resistance, inertia mass, cooling requirements, exhaust gas sampling procedure and other test bench specifications.

3. STRUCTURE OF THE PROJECT

The development of the cycle and the gearshift procedure belongs to the tasks of the WMTC group; the prescription of test bench settings was developed in working group 17 of ISO TC22 in close liaison with the WMTC group. Table 1 gives an overview of the tasks of the whole project.

In the work schedule of the WMTC group two validation steps were foreseen after the development of test cycle and gearshift procedure. A first step, in which the driveability was evaluated and a second step, in which the emissions measurement results were evaluated and compared with results from existing certification procedures. The development work and the two validation steps are finished. Finally, a round robin test was carried out starting in Spring 2003.

Step	Task	Status	Responsibility
1a	collection of statistics about stock and vehicle use	completed	WMTC Subgroup FE
1b	remonitoring of statistics about vehicle stock and use	completed	
1c	collection and analysis of in-use driving behaviour data	completed	
2a	cycle development	completed	
2b	gearshift prescription development	completed	
3a	driveability	completed	
3b	update of measurement procedure	completed	
3c	emissions validation tests	completed	
3d	analysis of emissions results	completed	
3e	classification	completed	
3f	weighting factors	completed	
4a	road load resistance	completed	ISO TC 22, SC 22, WG 17
4b	def. of inertia mass	completed	
4c	cooling requirements	completed	
4d	exhaust gas sampling procedure	completed	
5	Final measurement procedure (test protocol including cycle, gearshift prescr., add. Specifications)	completed	WMTC Subgroup FE
6	off cycle emissions provisions	waiting for definitions and criteria from the GRPE off-cycle WG	
7a	preparation of round robin test	completed	
7b	round robin test	completed	
7c	analysis of results	completed	
8a	Test procedure, GTR text without performance requirtements	completed	
8b	GTR incl. Performance requirements and off cycle emissions provisions	under work	

Table 1: The Structure of the whole project

4. CYCLE DEVELOPMENT

4.1. Approach

The basis of the cycle development was the collection and analysis of driving behaviour data and statistical information about motorcycle use for the different regions of the world. These data had to include all relevant real life vehicle operations and built the basis for the cycle development. In a second step the in-use driving behaviour data were combined with the statistics on vehicle use in order to create a reference database that is representative for worldwide motorcycle driving behaviour. This was achieved using a classification matrix for the most important influencing parameters. In the final classification matrix three different regions (Europe, Japan, USA), three different vehicle classes and three different road categories were included.

The next step was to compact this reference cycle into a test cycle of the desired length. A computer search programme then selects a number of modules (speed/time sequences between two stops) to represent by approximation this length. The statistical characteristics of this number of modules are then compared to those of the database. The comparison is done on the basis of the chi-squared method, an accepted statistical criterion.

Finally, a first draft of the World-wide Motorcycle Test Cycle (WMTC) was produced. It was foreseen that this first draft needed to be modified on the basis of an evaluation concerning driveability and practical points concerning the measurement procedure. Since this process is iterative by nature, several adaptation rounds including the driveability tests were carried out.

A flow chart of the development process is shown in Table 2.

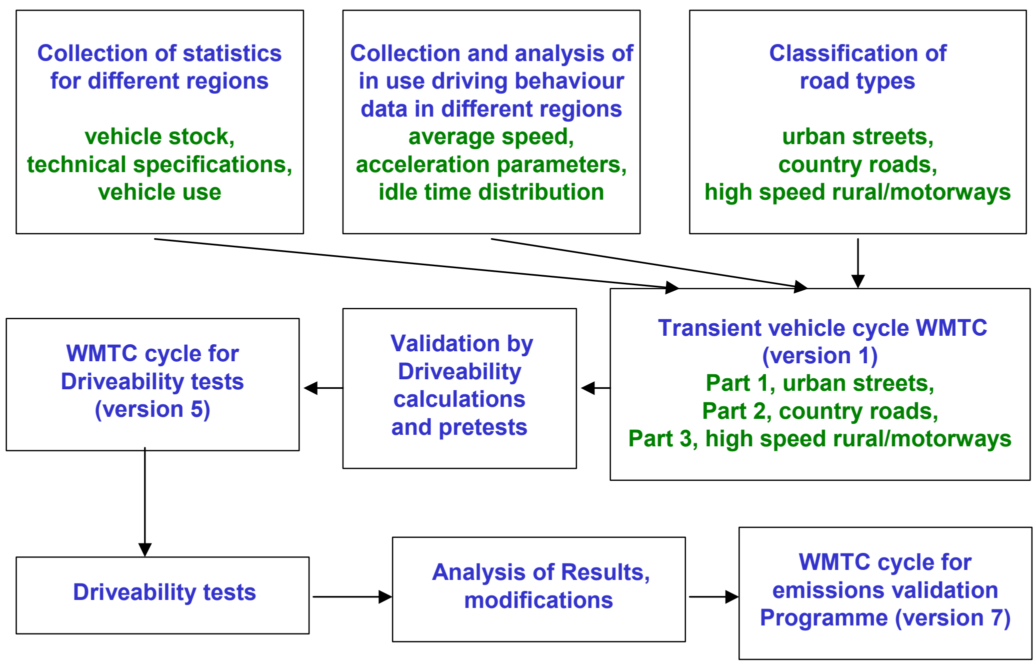

Table 2: Flow chart of the cycle development work

4.2. In-use driving behaviour data

The basis of the cycle development was the collection and analysis of driving behaviour data and statistical information about motorcycle use for the different regions of the world. These data had to include all relevant real life vehicle operations and built the basis for the cycle development. In a second step the in-use driving behaviour data were combined with the statistics on vehicle use in order to create a reference database that is representative for worldwide motorcycle driving behaviour. This was achieved using a classification matrix for the most important influencing parameters. In the final classification matrix three different regions, three different vehicle classes and three different road categories were included.

The in use driving behaviour data used for the WMTC project consist of the following subsets:

- Data measured in Europe
  1994, ACEM-group. The measurements were carried out in Paris and Pisa.
  1994, JAMA-group. The measurements were carried out in Amsterdam and Frankfurt.
  1999, ACEM. The measurements were carried out in the area around Pisa (Italy), the area around Mandeure (France) and the area around Munich (Germany).
  Technische Fachhochschule Biel in Switzerland, in and around Biel.
  Technical University of Darmstadt (Germany), around Darmstadt.

- Data measured in Japan
  1992, JMOE project. The measurements were carried out in the Tokyo area.
  1997, JAMA project. The measurements were carried out in the Tokyo area.
  2000, JAMA/JARI project. The measurements were carried out in the Tokyo area including highway. The data is only used for the gearshift model.

- Data measured in China
  In the Ji Nan area by the Tianjin Motorcycle Technical Center of the Tianjin Internal Combustion Engine Research Institute, belonging to the Tianjin University in China.

- Data measured in the USA
  1999, USMMA run. The measurements were carried out in Birmingham, Alabama.

The time duration and the total mileage of these in-use data subsets are shown in Table 3.
Table 4 gives an overview about the vehicle sample.

Dataset	**Total time (hours)**	**Total distance (km)**
ACEM 1999, Europe	175	9940
Biel data, Switzerland	17	590
Darmstadt data, Germany	109	6370
JMOE 1992, Japan	17	398
JAMA 1997, Japan	14	306
JAMA/JARI 2000, Japan	29	1185
China	7	190
USMMA 1999, USA	150	8245
TOTAL	**518**	**27224**

Table 3: Duration and mileage of the in-use data subsets

Region	Dataset	Vehicles		Capacity in cm³	Rated power in kW	power to mass ratio in kW/t
Europe	IMMA 1994, ACEM-group	Piaggio	80	80	≈ 6	≈ 30
		Cagiva	125	125	≈ 11	≈ 55
		Triumph	Trident 900	885	70	245
		Ducati	916	916	80	295
		BMW	R 1100 RS	1085	66	225
		Harley Davidson	FLST	1340	67	105
	IMMA 1994, JAMA-group	Peugeot	SX 80	73	≈ 7	≈ 45
		Yamaha	DT 125	124	≈ 9	≈ 50
		Suzuki	DR 350 S	349	22	105
		Kawasaki	GDZ 500 S	498	25	100
		Honda	Transalp	583	37	137
	IMMA 1999	Peugeot	Elyseo	100	6.4	35
		Piaggio	Liberty	125	7.3	40
		Aprilia	Classic	125	11	47
		Piaggio	Vespa ET 4	150	8.4	44
		Yamaha	XV 535 S	535	35	130
		BMW	R 850 R	850	52	164
		Honda	CBR 1100 XX	1100	110	335
		Harley Davidson	Electraglide	1450	49	117
	Biel data	Honda	CB 450 S	450	≈ 38	≈ 150
	Darmstadt data	Honda	CB 500 (25 kW)	500	25	93
		Suzuki	GSX R600	600	72	263
		BMW	GSX-R 600	600	57	179
Japan	JMOE 1992	Japan A	Scooter	49	5	36
		Japan B	Scooter	99	6.6	42
		Japan C		249	21	102
		Japan D		399	34	125
	JAMA 1997	Yamaha	Scooter	49	5	35
		Honda	CB 400	399	39	146
	JAMA/JARI 2000	Japan 1		399	39	139
		Japan 2		599	57	187
		Japan 3		998	68	197
China	Tianjin Motorcycle Technical Centre	Qingqi (Suzuki)	QS 125	125	7.3	38
USA	IMMA 1999	Piaggio	Typhoon	125		
		Kymco		125		
		KTM	LXC 400	400	39	172
		Yamaha	Virago	535	34	124
		BMW	R 1100 RS	1085	67	224
		Harley Davidson	FLHCT	1300	41	96
		Honda	Valkyrie	1500	75	181

Table 4: The vehicle sample of the in-use driving behaviour database

4.3. Fleet composition and vehicle use

The content of this chapter is adopted from [1].

Vehicle Stock

From the industrial partners statistical data have been received as to the respective local vehicle fleets in different regions of the world. One should bear in mind, however, that the available data are not very "hard". One obvious problem with statistics from widely different sources is that usually they are not coherent. It has been attempted to limit the data to motorcycles of more than 50 cc, although it is not always clear whether the available statistics include or exclude the class below 50 cc. From an evaluation of the statistical data received, sufficient conclusions can nevertheless be derived as to the composition of the vehicle fleet in different regions of the world.

- Europe has a fleet that mainly consists of either small capacity vehicles, mainly scooters, on the one hand, and of large sports and touring bikes on the other, with few vehicles in between. The distribution is very country dependant. Generally speaking northern countries possess a large percentage of big bikes, whereas southern countries tend to have mainly small vehicles.
- Japan has a similar share of small vehicles as Europe, but has a more or less equal number in the middle category. Really big bikes are rare in Japan.
- The USA has mainly big bikes (most of them above 750 cc) and very few in the small and middle categories.

The situation is shown in Table 5.

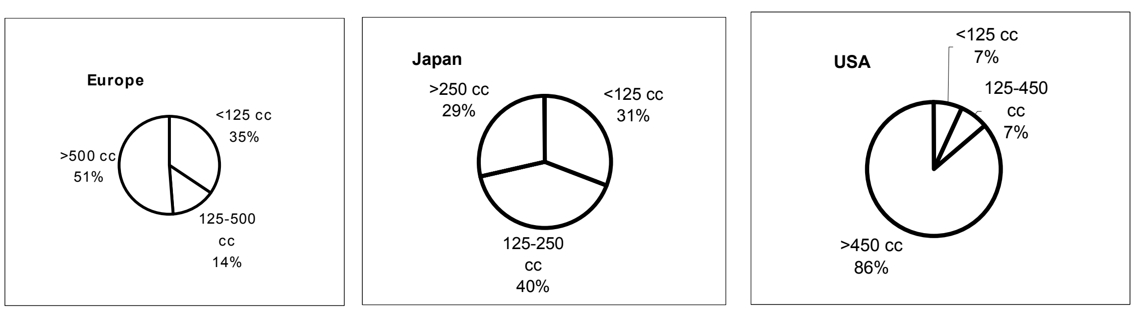

Table 5: The composition of the fleet in Europe, Japan and the USA in 1997. Note that the subdivision is not equivalent for all three regions, due to the structure of the available data. (from [1])

The total fleet size for Europe (that is including non-European Union Member States Switzerland and Norway), Japan and USA and the total annual mileage are shown in the following figure.

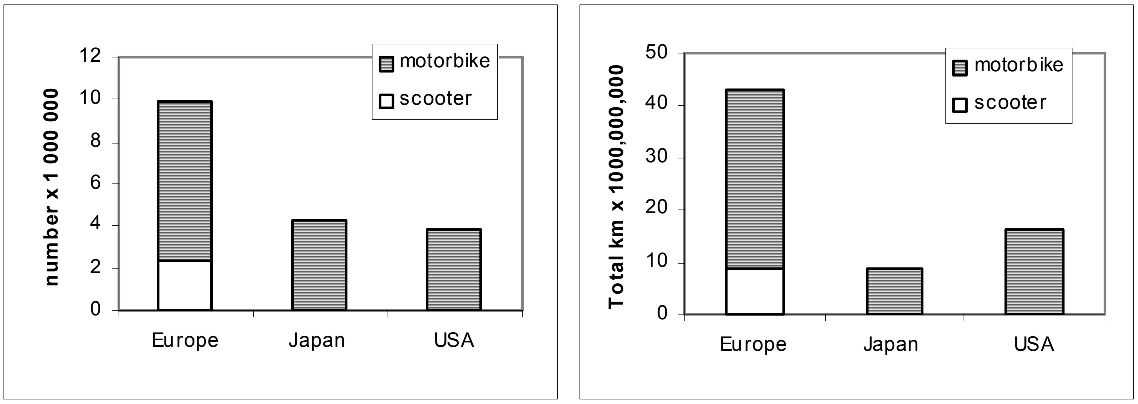

Table 6: The total fleet size in the three regions, numbers of vehicles (left) and total annual mileage (right), (from [1])

For Japan and the USA no figures about scooters are available.

Vehicle Use

One obvious problem when comparing the use on different road types in different parts of the world, is that the definitions, and often even the road types themselves, do not compare on a 1:1 basis. So any comparison can only be approximate. The following information was supplied by the IMMA members.

The characteristic use in Europe depends heavily on the class and the country. According to a user's survey by a major scooter manufacturer the small machines (mainly scooters) are almost exclusively used in an urban environment. The average trip length is small. This is the main pattern in south-European countries. According to a survey by the TU Darmstadt [2] the big machines are mainly used for recreational trips. The average trip length is large. This use is mainly on country roads, because the users are enthusiasts that like a challenging route. This agrees with available information from the Netherlands and it seems to be the dominant use in north-European countries.

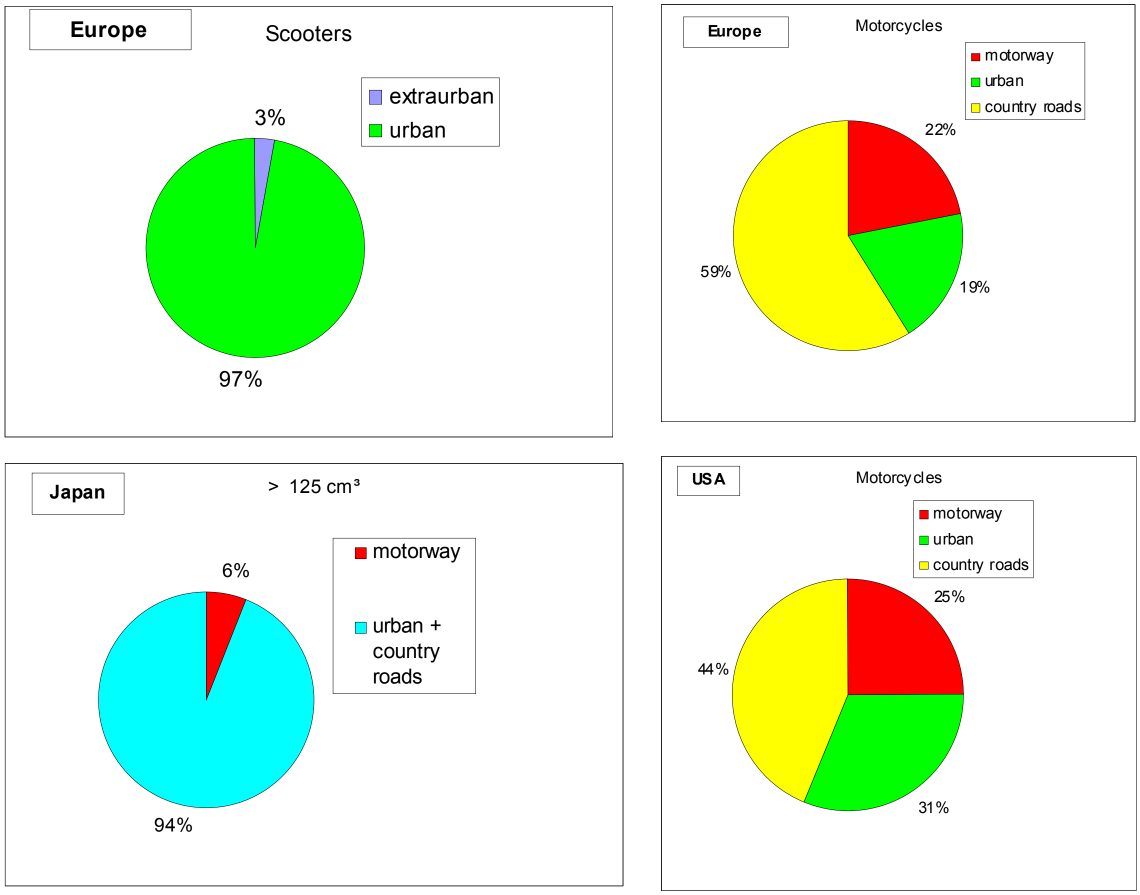

Table 7: Characteristic use per type of road (from [1], but corrected for US data)

The information that is available about Japan suggests that the majority of the mileage is performed on secondary roads, including urban roads. The maximum speed on country roads is 60 km/h. On motorways since October 2000 the posted speed is 100 km/h; before that date it was 80 km/h. Vehicles below 125 cc are not allowed on motorways, but even for bigger bikes the motorway share is small. Commuting and shopping are important motives in Japan. For the class < 125 cc 'business' is an important motive as well (26 per cent), whereas for the classes above 125 cc recreational use is an important motive (34 per cent for the class 125-250 cc, and 49 per cent for the class > 250 cc). The total annual mileages are low, suggesting small average trip lengths and low average speeds.

In the USA there is a larger share of urban use than in Europe and a smaller share of country roads. The use of motorways is roughly equal to that in Northern Europe. The annual mileages are relatively low and so are, presumably, the trip lengths.

Annual mileages are difficult to obtain, but the following table gives some indications.

Class	Region	Annual mileage
Engine capacity < 150 cm³	Europe Japan USA	2500 – 5000 km Approx. 1400 km 3000 – 3500 km
Engine capacity 150 – 450 cm³	Europe Japan USA	Approx. 3500 km Approx. 2300 km 3750 – 4250 km
Engine capacity > 450 cm³	Europe Japan USA	Approx. 5000 km Approx. 2400 km 5000 – 5500 km

Table 8: Approximate annual mileages per capacity class and region (from [1], but corrected for USA data)

4.4. The reference database

It was originally planned to create the reference database by combining the in-use driving behaviour data with the statistics on vehicle use (see Table 9). This should be done using a classification matrix for the most important influencing parameters. In the classification matrix three different regions, three different vehicle classes and three different road categories should be included.

The reference database would then have been a combination of representative in-use data expressed in terms of vehicle speed for each cell of the classification matrix and with the corresponding weighting factors.

But since the data about vehicle use were not reliable enough and since the WMTC group could not find a compromise for the vehicle classification the following alternative approach was chosen:

The cycle should be designed as consisting of three parts, each part representing a separate road category. Part 1 should be a low speed part, mainly representative for urban traffic; part 2 should be a medium speed part and represent slower country road type of traffic, and part 3 should be a high-speed part and represent faster country roads and motorways. Part 1 should incorporate a cold start.

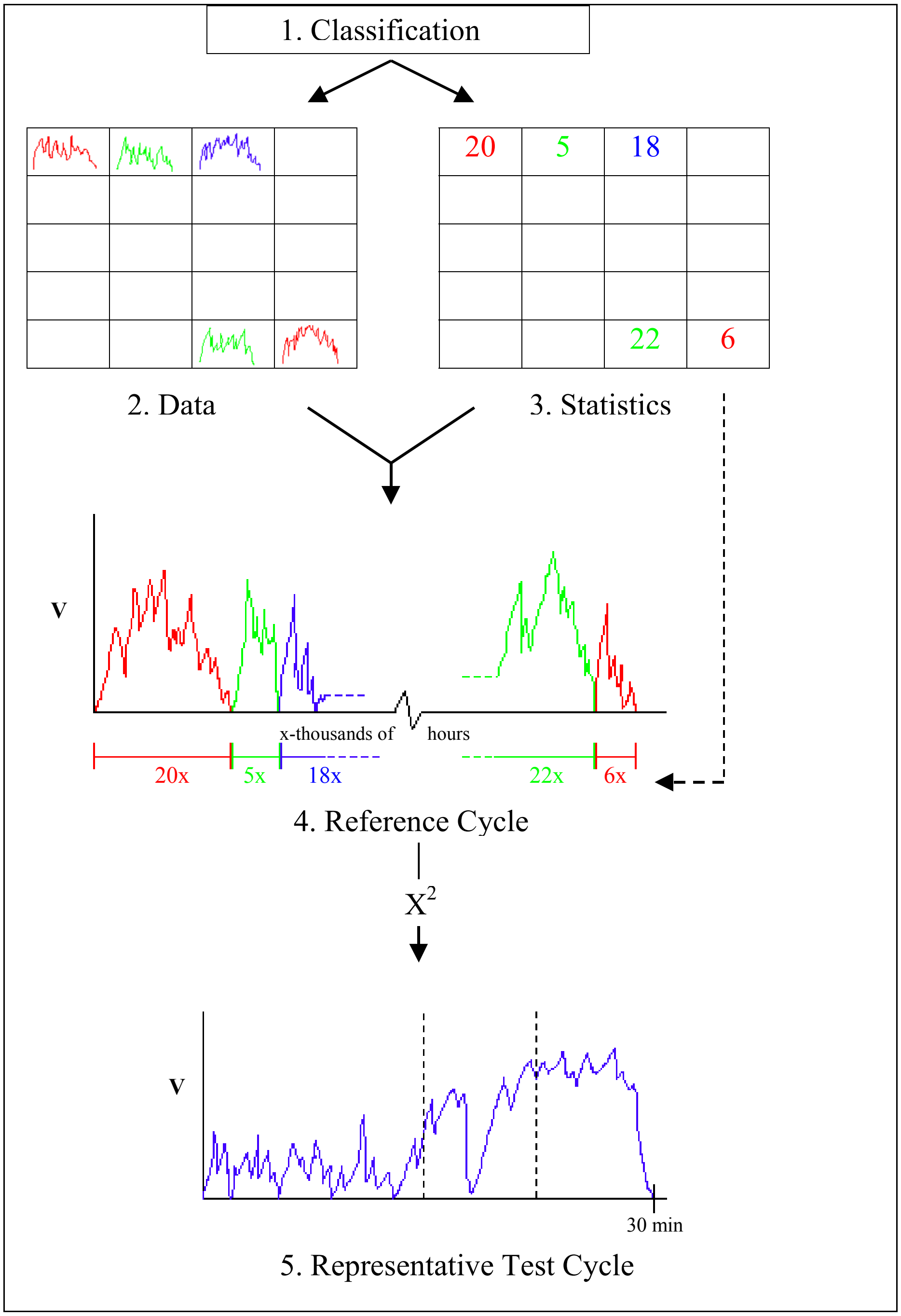

Table 9 Flowchart for the construction of a test cycle out of a large randomly distributed database, from [1].

By measuring the emissions separately for each part, this approach allows to perform validation tests with a provisional vehicle classification and take into account vehicle use statistics by applying weightings to the results for each part. Consequently the in-use data were separated into 3 classes corresponding to the above-mentioned 3 road categories.

Since information of road categories was not available for all in-use data and since the classification may vary from region to region, it was attempted to characterise the road categories, for a vehicle for which these categories were known, on the basis of the length of vehicle speed modules and the average speed of these modules. A module is a speed sequence between two stops. This was not very successful, partly because of the routes chosen. A second attempt on the basis of average speed and maximum speed per module looked more promising. There was a reasonable distinction between the road categories. The main overlap was between fast country and motorway traffic, but this was acceptable, as both categories should build one single class.

Eventually an approach was chosen that characterises the modules on the basis of speed distribution. This approach was used earlier for a similar problem in characterising the road use of hybrid driven passenger cars. To this end for every module the share of speeds was calculated below 60 km/h, between 60 and 90 km/h and above 90 km/h. Subsequently the following allocation was used:

Allocation of driving	
Part 1	**0-60 km/h >= 80 per cent**
	90+ km/h = 0 per cent
	Vmax <= 80 km/h
	additionally: length of sequence >= 1m
Part 2	**0-60 km/h <= 70 per cent**
	60-90 km/h >= 30 per cent
	90+ km/h <= 50 per cent
	Vmax <= 110 km/h
Part 3	**0-60 km/h <= 20 per cent**
	90+ km/h >= 50 per cent

Table 10: Allocation of driving types for the three cycle parts

This approach was selected as a pragmatic solution to the problem. The additional requirement of Part 1 was included to prevent "creeping" from being selected as a representative driving mode. Subsequently this way of allocation was applied to all data.

The second step then was to compact these reference cycles into test cycle parts of the desired length in time, which was set to 600 s for each part. A computer search programme was the developed by TNO that selected a number of modules (speed/time sequences between two stops) to represent by approximation this length. The statistical characteristics of this number of modules were then compared to those of the corresponding database.

The comparison was done on the basis of the chi-squared method for the acceleration versus speed matrix (v*a-matrix). The selection of modules with the lowest value for chi-squared was then selected as the ideal combination. So first the ideal lengths of the various modules were determined, and then the most representative modules corresponding with those lengths were selected. After the module selection the stops were added. The total stop time was taken from statistics. This total stop time was then divided into stops on the basis of the statistical distribution of the stop lengths in the in-use database. Finally a first draft of the World-wide Motorcycle Test Cycle (WMTC) was produced.

The cycle development work was done in close cooperation between JARI, TNO and RWTUEV. JARI contributed with an extensive in-use data analysis with respect to cycle development work, dealing with statistical distributions of vehicle speed, idling time, trip length, acceleration, deceleration and cruising phases (see [5] and [6]).

4.5. Modifications of the draft test cycle and final version

It was foreseen that the first draft needed to be modified on the basis of an evaluation concerning driveability and practical points concerning the measurement procedure. Since this process is iterative by nature, several adaptation rounds including the first step of the validation programme were carried out.

The following modifications were made during the validation phase and the driveability tests:

- Deletion of an ultra short module with operational speeds below 20 km/h in part 1,
- Separation of an extremely long module in part 1 into 3 parts that were more representative for urban driving,
- Replacement of 3 part 1 modules by more representative modules,
- Correction of the idle time distribution for part 1,
- Rearrangement of the rank order of the modules in part 1 with respect to cold start requirements,
- Smoothing of ripples in the quasi-constant cycle phases of parts 2 and 3 to delete unrealistic fluctuations in the speed signal caused by the speed measurement uncertainty,
- The maximum speed of part 3 was set to 125 km/h,
- The acceleration time pattern was smoothed in order to delete unrealistic high changes of the acceleration rate that could cause driveability problems like tyre slip,
- The highest deceleration values were reduced to take into account that only the drive wheel brake is working on the roller bench.
- To reduce the risk for tyre slip the da/dt values were limited to:

  $-0.8\ m/s^2/s <= da/dt <= +0.8\ m/s^2/s$.

  Consequently the vehicle speed pattern were modified until da/dt falls into that range.
- A special part 1 cycle, called "part 1, 50 cc" was created for low powered motorcycles, whose technical specifications are close to mopeds, by limiting the top speed of part 1 to 50 km/h and limiting the acceleration/deceleration values to $+2/-2\ m/s^2$.

Although version 7 of the WMTC cycle was based on a smoothed acceleration pattern to avoid excessive changes in acceleration over time, the question of tyre slip was raised again at the WMTC meetings in Madrid (17.12.2001) and Geneva (16.01.2002). Consequently an additional analysis of this problem was executed. This analysis was based on the results of 4 vehicles (2 from the US and 2 from Japan), for which second by second data of roller speed as well as tyre speed had been delivered for the WMTC as well as for the US-FTP and TRIAS/ECE Regulation No. 40. The latter was only measured in Japan. The Japanese vehicles belong to Pclass 1 and 2, the US vehicles to Pclass 3 (see chapter 9.). The word "Pclass" stands for the provisional classification used for the emissions validation tests (see chapter 7.).

The tyre slip was calculated as difference between tyre speed and roller speed divided by the roller speed and expressed in per cent. That means tyre slip gives positive values, tyre lock negative values. In addition the change of acceleration rate per second was calculated for the acceleration values of the set speed.

The majority of tyre slip values >= 50 per cent occurred during the transition from standstill to driving, surprisingly not only for the WMTC but also for the US-FTP and the TRIAS/ECE Regulation No. 40. The analysis results show that the dynamics of the WMTC do not cause higher risks for tyre slip than existing certification cycles. As already concluded from interim results and the analysis of the answers to the questionnaire about the tyre slip, the problem is related to individual tyre/roller combinations (see chapter 6.). Nevertheless it was decided in the WMTC group that the tyre slip risk should be minimised for the WMTC by limiting the change of acceleration rate in order to improve driveability, independent of the situation for existing cycles.

During the WMTC FE meeting in Tokyo in April 2002, the Japanese delegation proposed to create a special version of part 1 with a top speed of 50 km/h for low powered motorcycles whose technical specifications are close to mopeds. Since there is only one module in part 1 with vehicle speeds above 50 km/h (module 3), only this module was modified. The first part was replaced by a module taken from in-use measurements of vehicle 6 (this module was closest to the existing one) and the second part was lowered in speed to fulfil the limitation of 50 km/h.

The compromise found on vehicle classes made it necessary to create additional cycle versions with reduced speed also for part 2 and part 3. In order to achieve that the dynamics of the cycle parts with reduced speed were only changed slightly compared to the normal versions, the speed pattern was not simply limited by the reduced maximum but the whole module containing the maximum speed was lowered at its first acceleration phase and its last deceleration phase (e.g. see Table 13. For consistency reasons this approach was then also applied to part 1, so that the second version of part 1, reduced speed is slightly different from the first version.

All modifications done in the adaptation rounds are described in detail in 15.ANNEX A

DESCRIPTION OF THE MODIFICATION WORK ON THE WMTC CYCLE. Tables containing version 9 are shown in 16. ANNEX B – FINAL CYCLE VERSION.

The final result is shown in Table 11 to Table 13. Each part is 600 s long. Part 1 representing urban driving consists of 8 modules interrupted by standstill at idling. The top speed is 60 km/h in the normal version and 50 km/h in the reduced speed version. Part 2 representing driving on secondary rural roads consists of 2 modules, the top speed is 95 km/h in the normal version and 85 km/h in the reduced speed version. Part 3 representing primary rural roads and motorways consists of 1 module, the top speed is 125 km/h in the normal version and 111 km/h in the reduced speed version.

The characteristics of the WMTC driving cycle(s) are shown in Table 14 and Table 15. The definitions for the driving modes are given in Table 16.

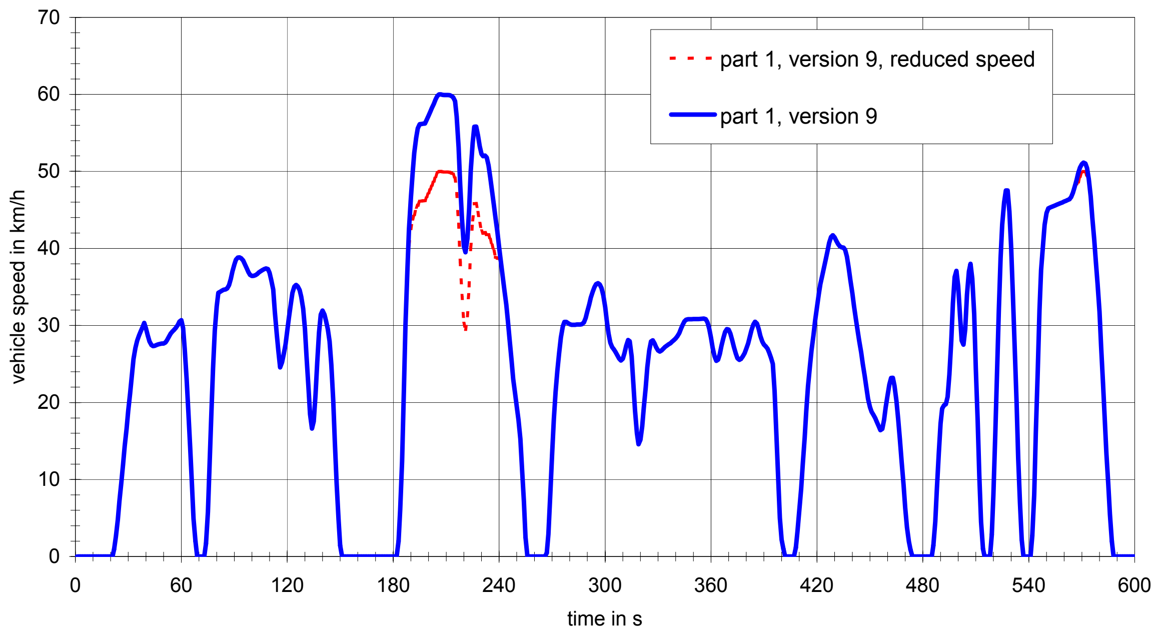

Table 11: WMTC driving cycle, part 1

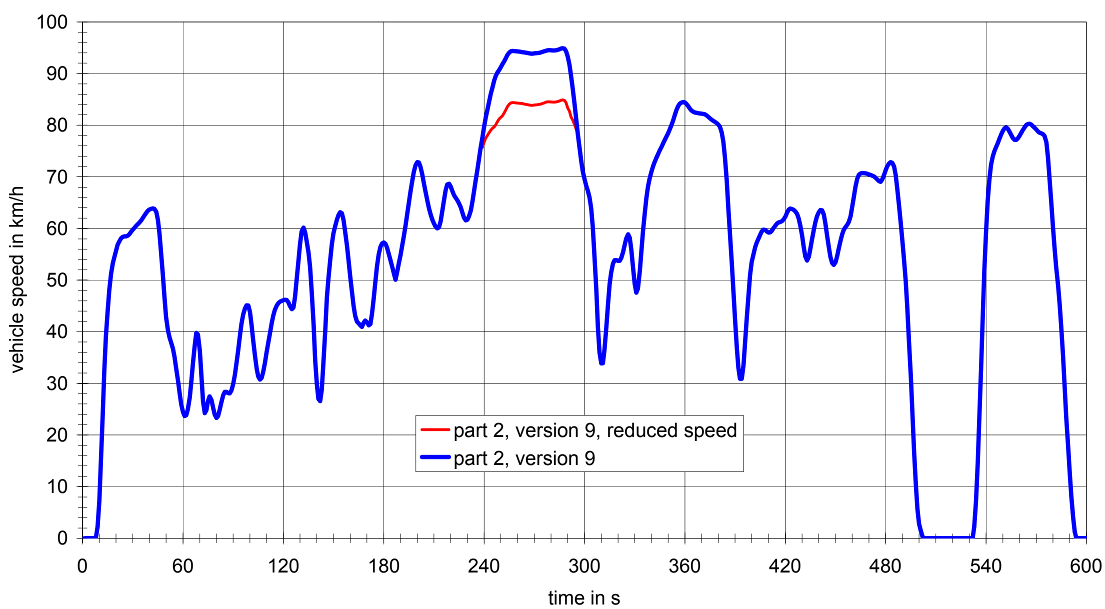

Table 12: WMTC driving cycle, part 2

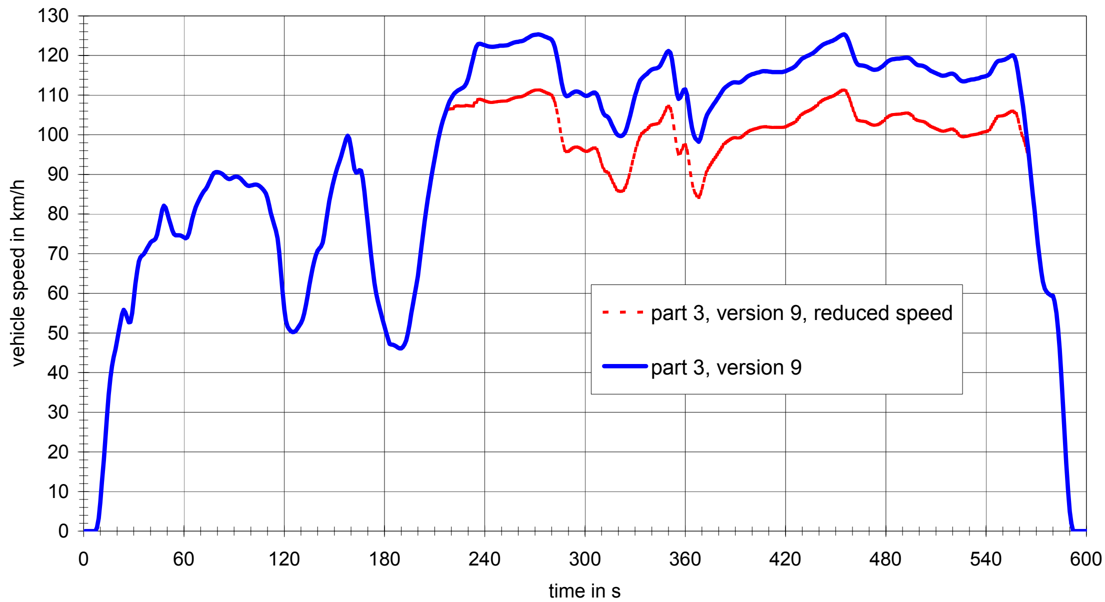

Table 13: WMTC driving cycle, part 3

part	time in s	distance in m		average speed in km/h		max acceleration in m/s²		max deceleration in m/s²	
		normal	reduced	normal	reduced	normal	reduced	normal	reduced
1	600	4065	3933	24.4	23.6	2.51	2.51	-2.00	-2.00
2	600	9111	8969	54.7	53.8	2.68	2.68	-2.02	-2.02
3	600	15736	14436	94.4	86.6	1.56	1.56	-2.00	-2.00

Table 14: Characteristics of WMTC driving cycle (1)

part	idle time ratio in per cent	acceleration time ratio in per cent	deceleration time ratio in per cent	cruise time ratio In per cent	average acceleration (acceleration mode) in m/s²	average deceleration (acceleration mode) in m/s²	average cruise speed (cruise mode) in km/h
1, normal	**17.0**	**28.3**	**28.2**	**26.5**	**0.69**	**-0.69**	**35.3**
1, reduced	**17.0**	**28.2**	**27.5**	**27.3**	**0.67**	**-0.69**	**34.5**
2, normal	**7.3**	**35.5**	**28.3**	**28.8**	**0.58**	**-0.73**	**70.4**
2, reduced	**7.3**	**34.3**	**28.3**	**30.0**	**0.59**	**-0.72**	**68.8**
3, normal	**2.5**	**25.7**	**18.5**	**53.3**	**0.47**	**-0.68**	**108.6**
3, reduced	**2.5**	**23.8**	**18.3**	**55.3**	**0.48**	**-0.65**	**97.9**

Table 15: Characteristics of WMTC driving cycle (2)

4 modes	Definition
idle mode	**vehicle speed** < 5km/h and -0.5 km/h/s (-0.139 m/s²) < **acceleration** < 0.5 km/h/s (0.139 m/s²)
acceleration mode	**acceleration** >= 0.5 km/h/s (0.139 m/s²)
deceleration mode	**acceleration** =< 0.5 km/h/s (0.139 m/s²)
cruise mode	**vehicle speed** >= 5km/h and -0.5 km/h/s (-0.139 m/s²) < **acceleration** < 0.5 km/h/s (0.139 m/s²)

Table 16: Definition of driving modes

5. GEARSHIFT PROCEDURE DEVELOPMENT

5.1. Approach

The development of the gearshift procedure was based on an analysis of the gearshift points in the in-use data. In order to get generalised relations between technical specifications of the vehicles and gearshift speeds the engine speeds were normalised to the utilisable band between rated speed and idling speed.

In a second step the end speeds (vehicle speed as well as normalised engine speed) for upshifts and downshifts were determined and collected in a separate table. The averages of these speeds for each gear and vehicle were calculated and correlated with technical specifications of the vehicles.

A flow chart of the development procedure is shown in Table 17.

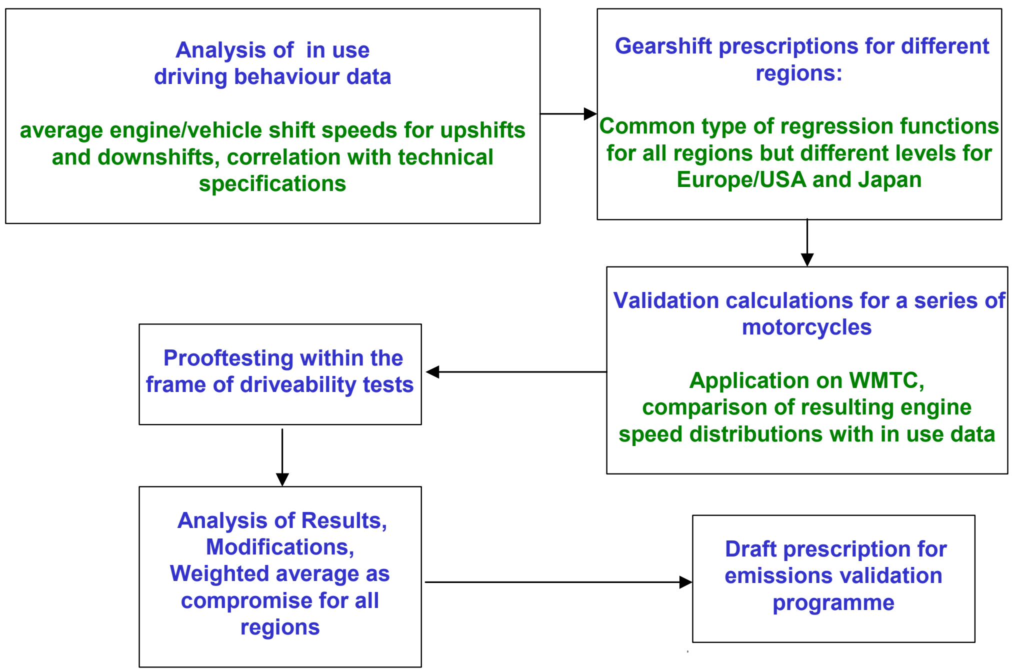

Table 17: Flow chart of the gearshift prescription development

The results of these analyses and calculations can be summarised as follows:

- The gearshift behaviour is engine speed related rather than vehicle speed related.
- The best correlation between gearshift speeds and technical data was found for normalised engine speeds and the power to mass ratio (rated power/(kerb mass + 75 kg), see Table 18.
- The residual variations cannot be explained by other technical data or by different transmission ratios. They are most probably assigned to differences in traffic conditions and individual driver behaviour.

- The best approximation between gearshift speeds and power to mass ratio was found for exponential functions, see Table 18.
- The gearshift function for the first gear is significantly lower than for all other gears.
- The gearshift speeds for all other gears can be approximated by one common function.
- No differences were found between 5-speed and 6-speed gearboxes.
- The gearshift behaviour in Japan is significantly different from the equal-type gearshift behaviour in Europe and in USA, see Table 18.

In order to find a balanced compromise between the three regions a new approximation function for normalised up shift speeds vs. power to mass ratio was calculated as weighted average of the Europe/USA curve (with 2/3 weighting) and the Japanese curve (with 1/3 weighting), see Table 19.

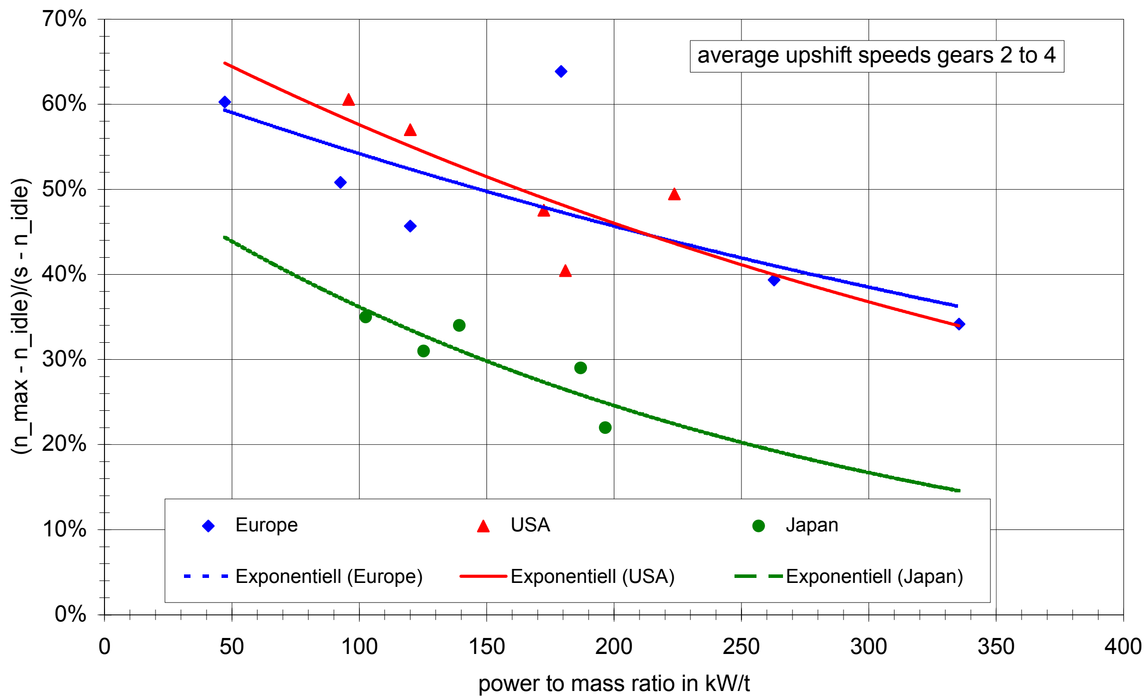

Table 18: Correlation between normalised max engine speeds for upshifts and power to mass ratio

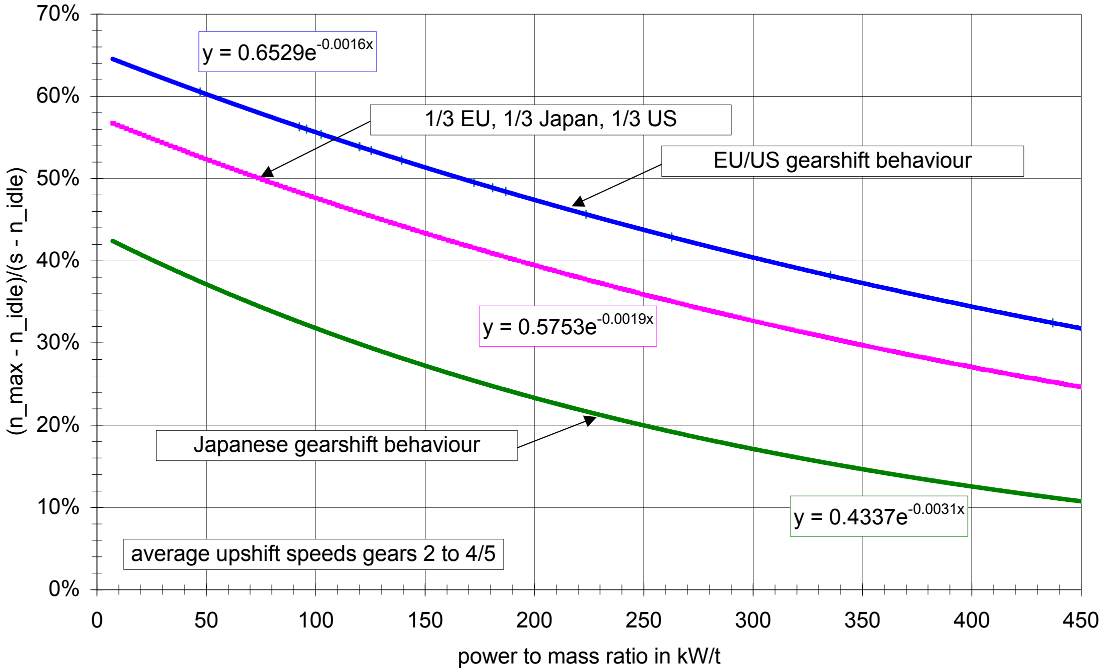

Table 19: The final approximation function for upshift speeds in gears higher than 1 (1/3 Europe, 1/3 Japan, 1/3 USA)

5.2. Gearshift criteria, additional requirements

Based on this, the gearshift prescriptions can be summarized as follows:

For acceleration phases manual transmissions shall be shifted from 1. to 2. gear when the engine speed reaches a value according to the following formula:

$$n\_max\_acc(1) = (0.5753 \times e^{(-1.9 \times \frac{P_n}{m_k + 75})} - 0.1) \times (s - n_{idle}) + n_{idle} \qquad \text{Equation 1}$$

Upshifts for higher gears have to be carried out during acceleration phases when the engine speed reaches a value according to the following formula:

$$n\_max\_acc(i) = (0.5753 \times e^{(-1.9 \times \frac{P_n}{m_k + 75})}) \times (s - n_{idle}) + n_{idle} \qquad \text{Equation 2}$$

P_n - rated power in kW
m_k – kerb mass in kg
n – engine speed in min^{-1}
n_{idle} – idling speed in min^{-1}
s - rated engine speed in min^{-1} at maximum power
i – gear number (>= 2)

The minimum engine speeds for acceleration phases in gear 2 or higher gears are accordingly defined by the following formula:

$$n\_min\_acc(i) = n\_max\_acc(i-1) \times \frac{r(i)}{r(i-1)} \qquad \text{Equation 3}$$

r(i) – ratio of gear i

The minimum engine speeds for deceleration phases or cruising phases in gear 2 or higher gears are defined by the following formula:

$$\boldsymbol{n\_min\_dec}\,(\mathbf{i}) = \boldsymbol{n\_min\_dec}\,(\mathbf{i}-\mathbf{1}) \times \frac{\boldsymbol{r}(\mathbf{i})}{\boldsymbol{r}(\mathbf{i}-\mathbf{1})} \qquad \text{Equation 4}$$

r(i) – ratio of gear I

When reaching these values during deceleration phases the manual transmission has to be shifted to the next lower gear (see Table 20).

The engine speed values resulting from the formulas above can be rounded to multiples of 100 min^{-1} for practical applications.

Table 20 shows an example for a gearshift sketch for a small vehicle. The solid lines demonstrate the gear use for acceleration phases; the dotted lines show the downshift points for deceleration phases. During cruising phases the whole speed range between downshift speed and upshift speed may be used.

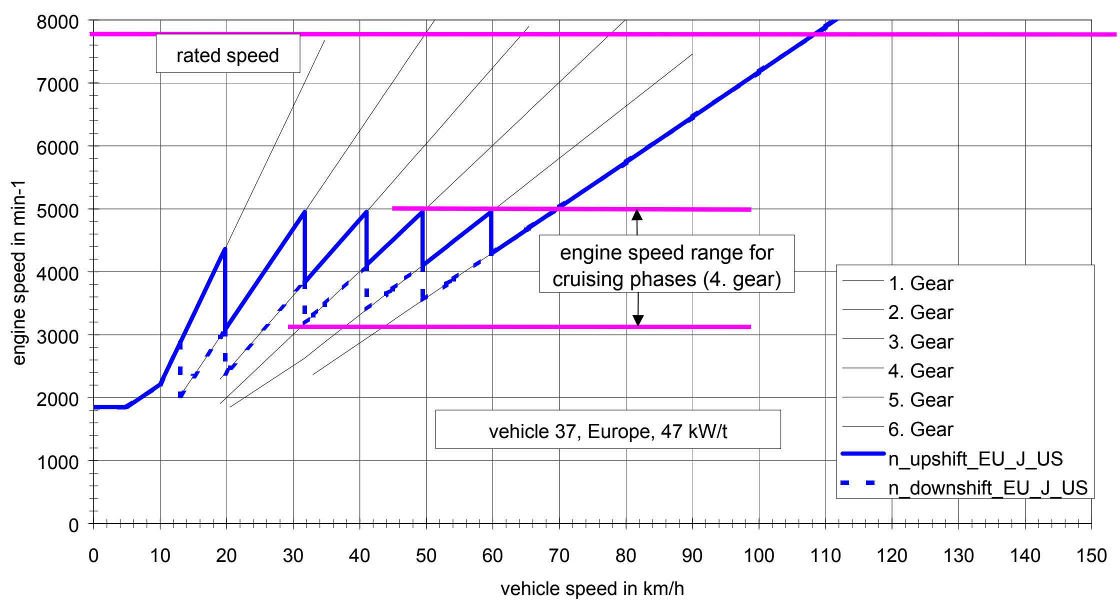

Table 20: Example of a gearshift sketch for a small vehicle

In order to avoid driveability problems these prescriptions had to be supplemented by the following **additional requirements**, (some of them are general, some are assigned to particular cycle phases):

- There are fixed allocations for acceleration, cruising and deceleration phases (see annex B).
- Gearshifts are prohibited for indicated cycle sections (see annex B).
- No gearshift if a deceleration phase follows immediately after an acceleration phase.
- Idle modes shall be run with manual transmissions in the first gear with the clutch disengaged.
- Downshifts to the first gear are prohibited for those modes, which require the vehicle to decelerate to zero.
- Manual transmissions gearshifts shall be accomplished with minimum time with the operator closing the throttle during each shift.
- The first gear should only be used when starting from standstill.
- For those modes that require the vehicle to decelerate to zero, manual transmission clutches shall be disengaged when the speed drops below 10 km/h, when the engine speed drops below $n_{idle} + 0.03*(s - n_{idle})$, when engine roughness is evident, or when engine stalling is imminent.
- While the clutch is disengaged the vehicle shall be shifted to the appropriate gear for starting the next mode.
- The minimum time span for a gear sequence is 2 seconds.

To give the test engineer more flexibility and to assure driveability the gearshift regression functions should be treated as lower limits. Higher engine speeds are permitted in any cycle phase.

These criteria and additional requirements were used to calculate the gearshift schedules for the test vehicles in the emissions validation programme. The definitions for acceleration, deceleration and cruising phases are given in Table 16.

5.3. Gearshift prescriptions

5.3.1. Step 1 – Calculation of shiftspeeds

Calculate upshift and downshift speeds for all gears according to the following formulas:

Upshift speeds in km/h during acceleration phases:

$$v_{1 \to 2} = \left[(0.5753 \times e^{\left(-1.9 \times \frac{P_n}{m_k + 75}\right)} - 0.1) \times (s - n_{idle}) + n_{idle} \right] \times \frac{1}{ndv_1}$$

Equation 5

$$v_{i \to i+1} = \left[(0.5753 \times e^{\left(-1.9 \times \frac{P_n}{m_k + 75}\right)}) \times (s - n_{idle}) + n_{idle} \right] \times \frac{1}{ndv_1}$$

, i = 2 to ng-1

Equation 6

Where
i is the gear number (>= 2),
ng is the total number of forward gears,
P_n is the rated power in kW,
m_k is the kerb mass in kg,
n is the engine speed in min^{-1},
n_{idle} is the idling speed in min^{-1},
s is the rated engine speed in min^{-1},
ndv_i is the ratio between engine speed in km/h and vehicle speed in min^{-1} in gear i.

Downshift speeds in km/h during cruise or deceleration phases in gears 3 to n:

$$v_{i \to i-1} = \left[(0.5753 \times e^{(-1.9 \times \frac{P_n}{m_k + 75})}) \times (s - n_{idle}) + n_{idle} \right] \times \frac{1}{ndv_{i-2}} \quad \text{, i = 3 to ng-1}$$

Equation 7

the gear lever shall set to first gear and the clutch shall be disengaged, if:
- the vehicle speed drops below 10 km/h, or
- the engine speed drops below $n_{idle} + 0.03*(s - n_{idle})$,
- engine roughness is evident,
- engine stalling is imminent.

5.3.2. Step 2 – Gear choice for each cycle sample

Calculate the appropriate gear for each sample according to phase indicators in the tables in annex B for those cycle parts that are appropriate for the test vehicle, as follows:

5.3.2.1. Gear lever in neutral and clutch disengaged

The gear lever shall be set to neutral and the clutch shall be disengaged, if the following conditions are met:
- During stop phases,
- During cruise or deceleration phases in second gear, if
  the vehicle speed drops below 10 km/h, or
  the engine speed drops below $n_{idle} + 0.03*(s - n_{idle})$.

5.3.2.2. Gear choice for acceleration phases
Gear = 6, if $v > v_{5\to6}$,
Gear = 5, if $v > v_{4\to5}$,
Gear = 4, if $v > v_{3\to4}$,
Gear = 3, if $v > v_{2\to3}$,
Gear = 2, if $v > v_{1\to2}$,
Gear = 1, if $v <= v_{1\to2}$.

5.3.2.3. Gear choice for deceleration or cruise phases

Gear = 6, if v > $v_{4\rightarrow5}$,
Gear = 5, if v > $v_{3\rightarrow4}$,
Gear = 4, if v > $v_{2\rightarrow3}$,
Gear = 3, if v > $v_{1\rightarrow2}$,
Gear = 2, if v <= $v_{1\rightarrow2}$.

5.3.3. Step 3 – Corrections according to additional requirements

The gear choice has then to be modified according to the following requirements:

a) No gearshift at a transitions from an acceleration phase to a deceleration phase: keep the gear that was used for the last second of the acceleration phase also for the following deceleration phase unless the speed drops below a downshift speed.
b) No upshifts during deceleration phases.
c) No gearshift in cycle phases, where "no gearshift" is indicated.
d) No downshift to first gear at a transition from a deceleration or a cruise phase to an acceleration phase, if "no 1. gear" is indicated.
e) If a gear is used for only one second, this gear shall also be assigned to the following second. Since it could happen that the modifications according to this criterion create new phases where a gear is used for only one second, this modification step has to be applied several times.

RWTUEV developed Excel calculation sheets for 3 to 6 speed gearboxes and both cycle versions (normal and reduced speed) as an assistant for test engineers. These sheets will be available on the UNECE/WP29 website: http://www.unece.org/trans/main/wp29/wp29wgs/wp29grpe/wmtc.html.

5.4. Calculation example

An example of input data necessary for the calculation of shift speeds is shown in Table 21. The upshift speeds for acceleration phases for the first gear and higher gears are calculated with equations 1 and 2. The denormalisation of engine speeds can be executed by using the equation:

n = n_norm * (s – n_idle) + n_idle.

The downshift speeds for deceleration phases can be calculated with equation 4. The n/v values in Table 22 can be used as gear ratios. These values can also be used to calculate the affiliated vehicle speeds (vehicle shift speed in gear i = engine shift speed in gear i / n/v_i). The corresponding results are shown in Table 22 and Table 23.

Engine capacity in cm^3	600
P_n in kW	72
m_k in kg	199
s in min^{-1}	11800
n_{idle} in min^{-1}	1150
ndv_1 *)	133.66
ndv_2	94.91
ndv_3	76.16
ndv_4	65.69
ndv_5	58.85
ndv_6	54.04
pmr **) in kW/t	262.8

*) **ndv** means the ratio between engine speed in min^{-1} and vehicle speed in km/h

) ***pmr* means the power to mass ratio calculated by $P_n / (m_k+75) \times 1000$, P_n in kW, m_k in kg

Table 21: Input data for the calculation of engine and vehicle shift speeds

	EU/USA/Japan driving behaviour	
	n_acc_max (1)	***n_acc_max*** (i)
n_norm*)	24.8 per cent	34.8 per cent
n in min^{-1}	3804	4869

*) ***n_norm*** means the calculated value by equation 1 and equation 2.

Table 22: Shift speeds for acceleration phases for the 1. gear and for higher gears (according to Table 21)

	EU/USA/Japan driving behaviour		
upshifts	v in km/h	n_norm_i	n_i in min-1
1->2	**28.5**	**24.9%**	**3804**
2->3	**51.3**	**34.9%**	**4869**
3->4	**63.9**	**34.9%**	**4869**
4->5	**74.1**	**34.9%**	**4869**
5->6	**82.7**	**34.9%**	**4869**
downshifts			
2 -> cl	**15.5**	**3.0%**	**1470**
3 -> 2	**28.5**	**9.6%**	**2167**
4 -> 3	**51.3**	**20.8%**	**3370**
5 -> 4	**63.9**	**24.5%**	**3762**
6 -> 5	**74.1**	**26.8%**	**4005**

Table 23: Engine and vehicle shift speeds according to Table 22

In a further step the possibility of a simplification of the above-described gearshift algorithms was examined by additional analyses and calculations. It should especially be checked whether engine shift speeds could be replaced by vehicle shift speeds. The analysis showed that vehicle speeds could not be brought in line with the gearshift behaviour of the in-use data.

6. DRIVEABILITY TESTS

Right after the WMTC cycle and the corresponding gearshift procedure were developed measurements were carried out on roller benches in order to validate the driveability of the cycles and the functionality of the gearshift procedure.

In order to run these tests a test protocol was developed on the basis of the test protocol of the USA certification procedure FTP. Some modifications were necessary due to the different design of the WMTC cycle (higher vehicle speeds, 3 parts) and the gearshift procedure. The gearshift protocol represented EU/USA gearshift behaviour because the Japanese gearshift behaviour database was not complete at that time.

In total the results (roller speed data) of 27 vehicles were delivered, 18 from Europe, 6 from Japan and 2 from the USA.

The driveability problems that were reported can be focussed on tyre slip, wheel lock and traceability problems due to poor power in case of low power vehicles. In addition some malfunctions of the gearshift calculation sheet were detected.

The problem with tyre slip and traceability was biggest for part 1 and smallest for part 3. It is obviously related to the individual roller-tyre combination. An additional questionnaire was sent out to all participants in order to get further information about the roller benches as well as about the tyres used for the measurements. The results of the questionnaire show big variations in technical specifications (diameter, maximum power, maximum speed) of the roller benches. The tyre slip problem could neither be related to tyre type or size nor to vehicle specifications. It is tyre related rather than roller bench related but the available tyre information is not suitable to show a clear picture about the influencing parameters. No tyre slip problems were reported for roller benches with "textured" surfaces. The results of the questionnaire do not suggest further reductions of the cycle dynamics during acceleration phases. The risk of tyre slip can be reduced by textured roller surfaces.

The wheel lock problem is partly caused by the fact that only the rear wheel break can be used during deceleration on a roller test bench and partly related to the tyre characteristics like the tyre slip problem. As there is no significant influence of the deceleration on the emissions the wheel lock problem can be reduced by a reduction of the deceleration values.

The poor power problem can only be avoided when the cycle dynamics are adjusted to the vehicles at the lower end of the power to mass ratio scale. But this solution would not be in line with practical use. Nevertheless countermeasures to the poor power problem should be further investigated.

7. VEHICLE CLASSIFICATION

The vehicle classification is one of the important issues of the WMTC development process. For practical reasons the following first provisional classification of vehicles was made by TNO within the frame of the cycle development work:

C-class I:	vehicles with an engine capacity of	< 150 cm³
C-class II:	vehicles with an engine capacity of	150 cc – 450 cm³
C-class III:	vehicles with an engine capacity of	> 450 cm³

During the analysis of the driveability validation test results some conflicts with practical use and technical possibilities revealed for this classification. On one hand there is a series of vehicles on the European market that would be classified as C-class I or C-class II although their maximum speed exceeds the maximum speed of the corresponding cycle parts substantially (see Table 24). On the other hand there are also vehicles of C-class 2 and C-class 3 whose maximum speed is below the maimum speed of the corresponding cycle parts.

max. vehicle speed	engine capacity		
	<= 150 cm³ in percent	> 150 cm³ <= 450 cm³ in percent	> 450 cm³ in percent
<= 95 km/h	**48.3**	**6.7**	**0.2**
> 95 km/h <= 125 km/h	**50.3**	**70.0**	**1.1**
> 125 km/h	**1.4**	**23.3**	**98.7**
sum	**100.0**	**100.0**	**100.0**

Table 24: Vehicle type distribution for engine capacity and maximum vehicle speed classes (data source: KBA statistics of type approval values)

For that reason some alternatives based on power to mass ratio and maximum vehicle speed as substitute or additional criteria were discussed but the FE-group could not find a compromise. It was decided to postpone a final decision till the analysis of the emissions validation test results will have been finished.

For the emissions validation tests the following provisional classification was used in order to get as much information as possible about the "border" areas:

Pclass 1:	vehicles with a maximum speed of less than 80 km/h,
Pclass 2:	vehicles with a maximum speed of 80 km/h or higher but less than 120 km/h,
Pclass 3:	vehicles with a maximum speed of 120 km/h or higher

Maximum speed is the maximum vehicle speed as declared by the manufacturer.

Since the existing classifications for motorcycle type approval in all three regions use engine capacity classes, the FE group reached an agreement that the classification system should be based on engine capacity and maximum vehicle speed.

During interim discussion phases it was agreed that the lower limit for class I is formed by engine capacity of more than 50 cm³ and maximum speed of more than 50 km/h, that special class I is defined by engine capacity of up to 50 cm^3 and maximum speed of more than 50 km/h but not more than 60 km/h.

But there was no agreement for maximum speed borders between the classes 1, 2 and 3 at that stage of the project. The proposals for a maximum speed border between class 1 and class 2 on one hand and class 2 and class 3 on the other hand that were discussed were justified by two contrasting philosophies about the driveability capabilities. Some members of the group argued that the classification must be defined in a way that the traceability is guaranteed for any cycle part, while some others would accept deviations from the cycle trace resulting in full throttle operation for about 10 per cent of the total cycle time in order to reproduce the practical use and in order to cover a wider area of the engine map. These contrary philosophies resulted in different proposals for maximum speed borders between class 1 and 2 (80 km/h versus 120 km/h) and class 2 and class 3 (120 km/h versus 140 km/h).

As part of the United Kingdom's contribution to the validation work of the WMTC working group, 12 motorcycles were tested by Ricardo over a near final version of the cycle. In the main, this work looked at machines that would be subject to all three parts of the new cycle. It was observed that motorcycles operating at or near their maximum speed would be subject to excessive and unrepresentative operation on full throttle. This would be necessary to achieve both the required speed and acceleration of the cycle. This observation suggests that there should be a reasonable allowance between the vehicle's potential maximum speed and the speed at which it is tested.

The United Kingdom proposed that a factor of $0.85*v_{max}$ for the maximum cycle speed would ensure an appropriate allowance. In order to smooth the transition between the vehicle classes, the United Kingdom recommended to develop cycles with reduced top speeds for all parts and use them for those vehicles whose speed factor ($0.85*v_{max}$) is below but close to the maximum speed of the original cycle part.

This approach was taken by the WMTC group and discussed. As the outcome of the discussion the following compromise was found in connection with additional cycle versions with reduced speeds for all cycle parts (see chapter 4.5.):

Class 1:

Vehicles that fulfil the following specifications belong to class 1:

engine capacity <= 50 cm^3 and 50 km/h < v_{max} < 60 km/h	**subclass 1-1,**
50 cm^3 < engine capacity < 150 cm^3 and v_{max} < 50 km/h	**subclass 1-2,**
engine capacity < 150 cm^3 and 50 km/h <= v_{max} < 100 km/h but not including subclass 1-1	**subclass 1-3.**

v_{max} is the maximum vehicle speed.

Class 2:

Vehicles that fulfil the following specifications belong to class 2:

engine capacity < 150 cm^3 and 100 km/h <= v_{max} < 115 km/h or engine capacity >= 150 cm^3 and v_{max} < 115 km/h	**subclass 2-1,**
115 km/h <= v_{max} < 130 km/h	**subclass 2-2.**

v_{max} is the maximum vehicle speed.

Class 3:

Vehicles that fulfil the following specifications belong to class 3:

130 <= v_{max} < 140 km/h **subclass 3-1,**
v_{max} >= 140 km/h **subclass 3-2.**

v_{max} is the maximum vehicle speed.

Table 25 gives an overview of the vehicle classification in terms of engine capacity and maximum vehicle speed.

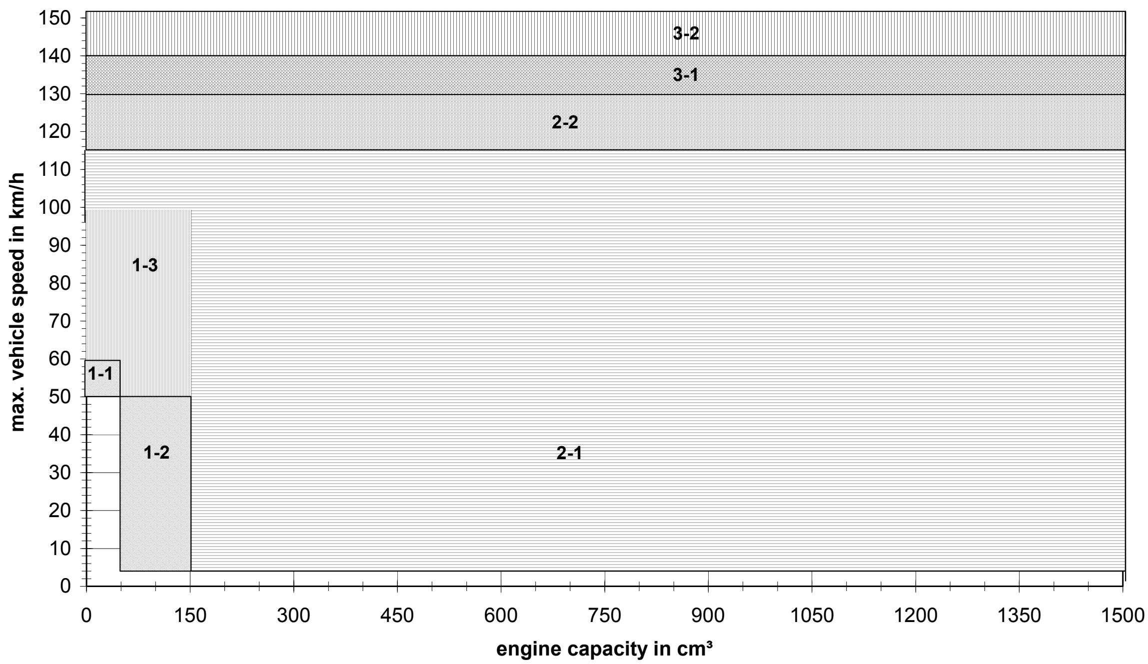

Table 25: vehicle classification

8. WEIGHTING FACTORS FOR AN OVERALL WMTC EMISSIONS RESULT

Another open question besides the vehicle classification is the calculation of an overall emissions result for class 2 and class 3 vehicles. As already mentioned in chapter 4.4., it is necessary to apply weightings to the emissions results of the different cycle parts in order to calculate an overall result that reflects the statistics of vehicle use, because otherwise the equal time length of 600 s for each cycle part leads to a coincidental weighting of 14 per cent for part 1, 31 per cent for part 2 and 55 per cent for part 3 that is not in line with practical use.

At the 8th WMTC FE meeting in Ann Arbor, JARI presented a calculation method that is based on the following in-use parameters:

- annual mileage for different road category,
- average one trip (engine start to stop) distance,
- equivalent cold start ratio

The equivalent cold start ratio is estimated by the soak time distribution and cold start factors. The cold start factor is 100 per cent for soak times > 6 hours and is 0 per cent when the coolant temperature reaches the temperature at hot condition. The equivalent cold start ratio is calculated by summarising the soak time frequency (derived from traffic surveys) multiplied with the cold start factor.

The weightings for the different cycle parts are derived from the annual mileage for different road categories. The weighting for part 1 is then splitted into a weighting for part 1, cold and part 1, hot. The weighting for part 1, cold is derived from the average one trip distance, the distance driven in part 1 and the equivalent cold start ratio. The weighting for part 1, hot is the difference between the total weighting for part 1 (derived from the annual mileage for urban use) and the weighting for part 1, cold.

The FE group agreed on the use of the Japanese approach for the weighting calculation. The Japanese delegates made also a proposal for a simplification in order to skip the measurement of part 1, hot for class 2 and class 3 vehicles, which was accepted by the majority of the FE group.

For Japan the statistical data needed for the weighting factor calculation were derived by national traffic monitoring and inventories. IMMA investigated similar data for Europe and the US. RWTUEV was asked to assess the statistical data delivered by different parties and work out a comparison of the results for weightings to be applied on the WMTC cycle parts based on averages of the 3 regions EU, USA, Japan. This comparison is shown in Table 26.

vehicle class	cycle	IMMA world wide	Steven_1 ww	Steven_2 ww	IMMA_EU_new	Japan
class 1	**part 1, cold**	**41.4%**	**63.4%**	**63.4%**	**38.6%**	**63.0%**
	part 1, hot	**58.6%**	**36.6%**	**36.6%**	**61.4%**	**37.0%**
class 2	**part 1, cold**	**27.7%**	**28.4%**	**28.4%**	**27.5%**	**28.0%**
	part 1, hot	**-**	**-**	**-**	**-**	
	part 2	**72.3%**	**71.6%**	**71.6%**	**72.5%**	**72.0%**
class 3	**part 1, cold**	**20.8%**	**20.4%**	**20.4%**	**16.2%**	**20.0%**
	part 1, hot	**-**	**-**	**-**	**-**	
	part 2	**62.8%**	**46.1%**	**52.6%**	**64.8%**	**77.0%**
	part 3	**16.4%**	**33.5%**	**27.0%**	**19.0%**	**3.0%**

Table 26: Comparison of different proposals for weighting factors

In a discussion between experts from the WMTC group, the EU Commission, Member States and NGO’s in late December 2002 it was agreed that the main problem of the weighting factor discussion is the lack of reliable statistical data for average trip length and mileage distribution for road categories. Nevertheless, the previous table shows a bias towards part 2. Therefore it was proposed to use simplified weighting values as shown in the following table:

Vehicle class	Cycle	Weighting	
Class 1	Part 1, cold	w_1	50 per cent
	Part 1, hot	w_{1hot}	50 per cent
Class 2	Part 1, cold	w_1	30 per cent
	Part 2, hot	w_2	70 per cent
Class 3	Part 1, cold	w_1	25 per cent
	Part 2, hot	w_2	50 per cent
	Part 3, hot	w_3	25 per cent

Table 27: Final weighting factors

The weightings have to be applied to the emission results and the fuel consumption as described below:

The emission results in g/km and the fuel consumption in litre/100 km are averaged for each cycle part. The (averaged) result of part 1 or part 1, reduced speed is named R_1, the (averaged) result of part 2 or part 2, reduced speed is named R_2 and the (averaged) result of part 3 or part 3, reduced speed is named R_3. Using these emission results in g/km and the fuel consumption in litre/100 km; the final result R, depending on the vehicle class as defined in chapter 7., shall be calculated by means of the following formulas:

$$\left.\begin{aligned} &\text{Class 1} \quad R = R_1 \times w_1 + R_{1\,hot} \times w_{1\,hot} \\ &\text{Class 2} \quad R = R_1 \times w_1 + R_2 \times w_2 \\ &\text{Class 3} \quad R = R_1 \times w_1 + R_2 \times w_2 + R_3 \times w_3 \end{aligned}\right\} \text{Equation 8}$$

for each pollutant, the carbon dioxide emission and the fuel consumption using the weightings shown in Table 27.

9. EMISSIONS VALIDATION TESTS

9.1. General information

One important step for the whole project was the emissions validation programme.
The following decisions/recommendations were made with respect to the emissions validation programme by the WMTC group:

a) Cycle version 7 (the latest version at that time) should be used for the bench tests, part 1 should be measured with cold start first and then repeated at the end in warm condition.

b) In case of poor power the cycle trace should be followed as good as possible.

c) The following provisional vehicle classification (indicated in tables and figures as "Pclass") should be used for the emissions validation programme:
   - Cycle part 1 is mandatory for all vehicles,

- Part 2 should be driven if v_max >= 80 km/h,
- Part 3 should be driven if v_max >= 120 km/h.

v_max is the maximum vehicle speed as declared by the manufacturer.

d) The gearshift procedure as described in chapter 5. should be applied. The use of higher engine speeds were allowed for driveability or practicability reasons.

To be able to start this programme in September 2000 updates of the test protocol, the gearshift procedure and the results delivery format were carried out and distributed amongst the participants of this programme. 21 scooters and 38 motorcycles were announced to be measured within this programme.

The following cycles were mandatory:

- Draft WMTC cycle for emissions validation programme, latest version,
- Appropriate regional certification cycle according to the corresponding measurement procedure.

For Europe, the test cycle as described in COM 2000 314 final EU's proposal for amendment of Directive 97/24/EC, section 5.3.1., appendix 1 should be used. Additional cycles like the European passenger car test cycle (EU Directive 98/69/EC, NEDC) for Europe were recommended. It was also recommended to measure additional conditions that can be used for off cycle emissions provisions.

The following guidelines were given for the road load settings:

It was recommended to perform coast down measurements on the road and use the results for the specification of load settings. If coast down measurements were not possible the settings of the US-FTP specifications should be used. If the maximum speed of a vehicle as declared by the manufacturer was below 130 km/h and this speed could not be reached on the roller bench with the US-FTP test bench settings, they had to be adjusted until the maximum speed was reached.

The following results should be delivered:

- Technical data of the vehicle including maximum speed,
- Bag results of the emissions for each part of the WMTC and other test cycles,
- Roller speed with 1 Hz resolution, drive wheel speed, if possible,
- Engine speed for vehicles with automatic gearbox (1 Hz resolution),
- Emissions with 1 Hz resolution,
- Temperatures at exhaust tailpipe and CVS metering device (1 Hz resolution),
- Temperature, barometric pressure and humidity of test cell,
- Humidity of dilution air.

The results of 54 vehicles were delivered:

- only bag results: 3 vehicles,
- bag results and roller speed (second by second): 19 vehicles,
- bag results, roller speed and engine speed (second by second): 8 vehicles,
- bag results, roller speed and emissions (second by second): 11 vehicles,
- bag results, roller speed, engine speed and emissions (second by second): 9 vehicles,

- bag results, roller speed, drive wheel speed and emissions (second by second): 2 vehicles,
- bag results, roller speed, drive wheel speed, engine speed and emissions (second by second): 2 vehicles

The following problems occurred in some cases:

- Some participants were not able to measure emissions with 1 Hz resolution,
- The road load setting requirements were not fulfilled,
- The provisional vehicle classification was not met,
- The speed tolerances were not met,
- Only bag results were delivered,
- The wrong cycle version was used. (This vehicle was excluded from the analysis).

But 90 per cent of the results could be used for further analysis.
Table 28 shows an overview of the vehicle sample distribution for different regions and provisional vehicle classes. 83 per cent of the vehicles were measured in Europe.

region	**number**	**Pclass 1**	**Pclass 2**	**Pclass 3**
EUR	45	10	16	19
JAPAN	6	2	2	2
USA	2			2
Sum	53	12	18	23

Table 28: Vehicle sample for the emissions validation test programme

Table 29 gives an overview of the distribution of engine type and reduction system within the vehicle sample, Table 30 shows the participating institutes/organisations and Table 31 contains the technical data of the vehicles.

It has to be pointed out that road load settings based on coast down measurements on road were recommended. If such coast down results were not available the settings of the US-FTP specifications should be used. But, these settings are no more up-to-date as the ISO/TC22/WG17 has shown on the basis of new measurements in Japan. In its final report the ISO group presented a new list with updated settings. The differences between US-FTP and ISO/TC22/WG17 settings are depending on vehicle mass and speed. For 11 vehicles the road load settings of the US-FTP were not appropriate, most of them are trial and enduro vehicles. It can be expected that for these vehicles the differences are significant.

engine type	reduction system	PClass 1	PClass 2	PClass 3
2-str	direct injection	1		
2-str	oxidation catalyst	4	1	
2-str	no	3	1	
4-str	3 way catalyst		2	9
4-str	3 way catalyst + Air injection			1
4-str	oxidation catalyst		1	4
4-str	oxidation catalyst + Air injection		1	1
4-str	air injection		4	3
4-str	no	4	8	5
	Sum	**12**	**18**	**23**

Table 29: Distribution of engine type and reduction system within the vehicle sample

region	institute	no of vehicles
Europe	ACEM	3
Europe	AECC	2
Europe	EMPA	2
Europe	HTA Biel	1
Europe	INTA	15
Europe	JRC	3
Europe	Ricardo	11
Europe	RWTÜV	8
Japan	JAMA	3
Japan	JARI	3
USA	Harley Davidson	2
	sum	**53**

Table 30: Institutes/organisations participating on the emissions validation test programme

region	no	engine type	reduction system	cain cm3	Pn in kW	v_max in km/h	max WMTC cycle part	max speed not reached
JAPAN	19	2-str	oxidation catalyst	49	4.8	60	1	x
EUR	15	2-str	oxidation catalyst	125	6.8	69	1	
EUR	42	2-str	oxidation catalyst	101	5.0	85	1	
EUR	43	4-str	no	96	5.6	82	1	
EUR	46	4-str	no	125	7.5	100	1	
EUR	48	2-str	no	250	6.8	75	1	
EUR	50	2-str	no	248	13.3	95	1	
EUR	71	2-str	no	125	8.2		1	
EUR	72	2-str	oxidation catalyst	84	6.3		1	
EUR	73	4-str	no	182	13.6		1	
EUR	79	2-str	Direct injection	49			1	
JAPAN	62	4-str	no	49	2.9	60	1	
EUR	16	2-str	no	272	14.0	82	2	x
EUR	17	4-str	no	649	8.8	98	2	x
EUR	41	4-str	Air injection	125	11.0	110	2	x
EUR	51	4-str	no	124	8.4	110	2	x
EUR	52	4-str	Air injection	125	11.0	103	2	x
JAPAN	63	4-str	Air injection	124	9.6	95	2	x
EUR	7	4-str	no	150	8.4	95	2	
EUR	31	4-str	3 way catalyst	125	11.0	100	2	
EUR	34	4-str	oxidation catalyst	124	8.0	90	2	
EUR	35	4-str	no	249	15.0	115	2	
EUR	47	4-str	no	249	14.7	115	2	
EUR	53	4-str	no	234	14.0	120	2	
EUR	54	4-str	no	239	14.3	125	2	
EUR	57	4-str	no	124	11.0	104	2	
EUR	67	4-str	3 way catalyst	125	11.0	103	2	
EUR	74	4-str	Air injection	150	8.8		2	
EUR	82	2-str	oxidation catalyst	50	6.7		2	
JAPAN	25	4-str	oxidation catalyst + Air injection	249	19.0	120	2	
EUR	36	4-str	oxidation catalyst	250	15.5	123	3	x
USA	28	4-str	oxidation catalyst	1449	25.0	130	3	x
EUR	13	4-str	oxidation catalyst	459	28.5	158	3	
EUR	32	4-str	3 way catalyst	1130	62.5	196	3	
EUR	38	4-str	3 way catalyst	1170	45.0	168	3	
EUR	39	4-str	3 way catalyst + Air injection	599	80.0	252	3	
EUR	40	4-str	3 way catalyst	1298	105.5	250	3	
EUR	60	4-str	oxidation catalyst	996	86.0	250	3	
EUR	65	4-str	no	748	54.4	185	3	
EUR	66	4-str	3 way catalyst	1171	72.0	200	3	
EUR	68	4-str	3 way catalyst	1064	67.0	220	3	
EUR	75	4-str	3 way catalyst	955	76.5		3	
EUR	76	4-str	oxidation catalyst + Air injection	790	44.5		3	
EUR	77	4-str	no	499	43.0		3	
EUR	78	4-str	Air injection	398	32.7		3	
EUR	80	4-str	3 way catalyst	1298	106.7		3	
EUR	81	4-str	no	249	15.5		3	
EUR	83	4-str	Air injection	649	29.4		3	
EUR	137	4-str	3 way catalyst	652	25.0	145	3	
EUR	160	4-str	no	996	86.0	250	3	
JAPAN	26	4-str	Air injection	399	24.0	140	3	
JAPAN	64	4-str	3 way catalyst	781	59.0	180	3	
USA	27	4-str	no	1199	44.5	177	3	

Table 31: Technical data of the vehicles

9.2. Results of the emissions validation programme

The results of the emissions validation tests are given in Table 32 to Table 35 in g/test and in Table 36 to Table 39 in g/km. The CO_2 values are measured values from the exhaust gas. The gtr (see [4]) provides the calculation procedure for the total CO_2 emission directly related to the fuel consumption.

Since the vehicle classification and the weightings were still under discussion, when the validation data analysis was performed, the results for the WMTC are shown for each cycle part separately, no overall WMTC result was calculated and no comparison with the results of the regional cycles was carried out.

NEDC denominates the European passenger car test cycle (EU Directive 98/69/EC), TRIAS denominates the Japanese type approval test cycle that is a modified version of the ECE Regulation No. 40.

A more detailed analysis of the validation test results can be summarised as follows:

The emissions variance is:

- Dependent of individual engine control technique,
- Dependent of emission level,
- Independent of traceability,
- Not different from others if the maximum roller speed is below the maximum set speed.

High variances in emissions results within each vehicle group (engine type/reduction system) due to individual vehicle design, high overlap in range between different groups

The high variances of the emissions results indicate that there is a substantial optimisation potential in some cases. As a consequence substantially lower variances can be expected if the reduction systems are optimised in accordance to the WMTC.

region	no	engine type	max WMTC cycle part	max speed not reached	NEDC	ECE R 40	WMTC, part 1, cold	WMTC, part 2	WMTC, part 3	WMTC, part 1, hot	US-FTP	TRIAS
JAPAN	19	2-str	1	x		8.403	16.240			9.510	25.964	8.403
EUR	15	2-str	1			31.140	41.597			22.070		
EUR	42	2-str	1			35.997	26.557			26.133		
EUR	43	4-str	1			3.310	3.553			3.170		
EUR	46	4-str	1			3.487	4.983			3.500		
EUR	48	2-str	1			114.817	54.190			57.227		
EUR	50	2-str	1			63.557	60.277			60.907		
EUR	71	2-str	1			66.367	50.347			56.533		
EUR	72	2-str	1			11.750	18.717			9.140		
EUR	73	4-str	1		8.440	2.880	2.825					
EUR	79	2-str	1		8.420	3.630	3.614					
JAPAN	62	4-str	1				3.598			3.042	7.659	2.787
EUR	16	2-str	2	x		58.083	40.680	65.910		37.750		
EUR	17	4-str	2	x		10.037	12.100	16.303		9.873		
EUR	41	4-str	2	x		7.573	10.090	18.390		8.477		
EUR	51	4-str	2	x		4.697	4.273	7.020		4.090		
EUR	52	4-str	2	x		5.957	7.973	12.207		5.867		
JAPAN	63	4-str	2	x			3.217	6.230		2.271	5.014	2.141
EUR	7	4-str	2			1.720	3.034	3.894		1.314		
EUR	31	4-str	2		5.627	1.342	3.139	3.041		0.817		
EUR	34	4-str	2		5.671	1.878	3.211	5.376		2.089		
EUR	35	4-str	2		9.123	5.050	4.043	6.900		4.340		
EUR	47	4-str	2			1.998	2.827	4.500		2.047		
EUR	53	4-str	2			8.190	11.693	15.350		7.283		
EUR	54	4-str	2			3.630	4.750	5.313		3.127		
EUR	57	4-str	2			5.782	7.149	8.103	5.566			
EUR	67	4-str	2		4.823	0.762	2.851	2.601		0.685		
EUR	74	4-str	2		15.080	12.540	11.569	13.830				
EUR	82	2-str	2		38.281	4.289	29.121	32.379				
JAPAN	25	4-str	2				2.880	4.603		2.454	5.619	0.987
EUR	36	4-str	3	x	5.728	2.345	2.890	4.722	7.298	1.867		
USA	28	4-str	3	x			11.704	5.404	6.278			
EUR	13	4-str	3			2.203	3.593	3.442	4.719	2.047		
EUR	32	4-str	3		5.811	0.515	6.280	1.584	1.616	1.893		
EUR	38	4-str	3		4.884	0.655	6.168	1.461	0.692	1.012		
EUR	39	4-str	3		5.067	1.434	4.052	3.757	10.856	5.423		
EUR	40	4-str	3		4.164	1.106	1.844	2.099	3.548	2.037		
EUR	60	4-str	3			4.941	9.492	8.151	11.582	6.398		
EUR	65	4-str	3			9.137	11.043	9.213	8.247	6.547		
EUR	66	4-str	3		4.922	0.662	5.328	1.871	2.732	1.026		
EUR	68	4-str	3		0.868	0.110	0.816	0.168	0.459	0.365		
EUR	75	4-str	3		7.890	3.230	4.428	6.046	11.342			
EUR	76	4-str	3		4.070	0.910	2.406	3.175	6.641			
EUR	77	4-str	3		10.660	6.120	5.812	9.459	10.183			
EUR	78	4-str	3		11.030	6.950	7.083	12.744	11.083			
EUR	80	4-str	3		4.753	1.241	0.403	3.423	5.627			
EUR	81	4-str	3		6.901	3.004	6.520	5.842	6.792			
EUR	83	4-str	3		8.872	2.446	4.307	6.692	7.831			
EUR	137	4-str	3		1.757	0.449	3.622	3.658	2.621	2.338		
EUR	160	4-str	3			5.476	5.945	8.809	7.101	4.756		
JAPAN	26	4-str	3		7.939		6.082	7.837	8.321	2.520	10.151	2.609
JAPAN	64	4-str	3		4.237		3.179	3.872	5.244	1.157	4.825	1.106
USA	27	4-str	3				18.027	8.202	6.855			

Table 32: Results of the emissions validation tests for HC in g/test

region	no	engine type	max WMTC cycle part	max speed not reached	NEDC	ECE R 40	WMTC, part 1, cold	WMTC, part 2	WMTC, part 3	WMTC, part 1, hot	US-FTP	TRIAS
JAPAN	19	2-str	1	x		16.94	22.79			19.19	62.18	16.94
EUR	15	2-str	1			46.36	42.69			40.43		
EUR	42	2-str	1			71.39	61.92			60.20		
EUR	43	4-str	1			56.84	57.45			58.84		
EUR	46	4-str	1			53.00	51.99			56.13		
EUR	48	2-str	1			162.90	129.04			129.21		
EUR	50	2-str	1			132.93	124.56			121.31		
EUR	71	2-str	1			116.61	99.71			100.08		
EUR	72	2-str	1			47.52	38.64			49.26		
EUR	73	4-str	1		118.75	18.01	27.17					
EUR	79	2-str	1		6.68	1.91	2.88					
JAPAN	62	4-str	1				21.05			24.14	56.31	22.53
EUR	16	2-str	2	x		110.89	86.39	134.36		87.07		
EUR	17	4-str	2	x		170.94	165.64	288.43		176.25		
EUR	41	4-str	2	x		38.52	58.82	181.88		54.63		
EUR	51	4-str	2	x		62.91	56.96	204.97		69.65		
EUR	52	4-str	2	x		43.25	55.70	160.73		54.59		
JAPAN	63	4-str	2	x			41.46	125.23		47.33	110.08	39.77
EUR	7	4-str	2			13.10	15.00	63.27		15.14		
EUR	31	4-str	2		39.18	3.32	6.90	26.85		4.20		
EUR	34	4-str	2		117.15	12.50	21.49	101.61		22.08		
EUR	35	4-str	2		92.95	28.17	29.14	55.24		40.13		
EUR	47	4-str	2			38.20	31.57	91.34		36.76		
EUR	53	4-str	2			127.59	140.43	261.43		122.19		
EUR	54	4-str	2			61.80	65.73	110.01		69.45		
EUR	57	4-str	2			30.58	25.41	65.70	24.06			
EUR	67	4-str	2		50.95	3.26	7.96	30.39		4.70		
EUR	74	4-str	2		72.25	23.29	29.69	63.06				
EUR	82	2-str	2		41.20	2.51	29.80	116.75				
JAPAN	25	4-str	2				30.04	145.63		33.25	105.20	19.65
EUR	36	4-str	3	x	173.11	61.78	63.12	120.89	211.01	53.00		
USA	28	4-str	3	x			64.78	24.81	216.69			
EUR	13	4-str	3			17.26	24.26	36.33	86.20	19.22		
EUR	32	4-str	3		52.38	6.69	55.73	21.88	19.01	21.13		
EUR	38	4-str	3		83.95	15.11	81.87	24.33	31.03	21.12		
EUR	39	4-str	3		41.21	1.91	25.11	32.54	161.72	18.72		
EUR	40	4-str	3		14.57	4.56	10.45	7.74	8.75	4.83		
EUR	60	4-str	3			4.94	12.33	12.84	78.73	5.64		
EUR	65	4-str	3			29.03	33.76	37.68	50.21	29.65		
EUR	66	4-str	3		21.47	2.96	18.21	9.30	12.81	3.95		
EUR	68	4-str	3		4.17	0.66	3.36	0.71	3.06	1.39		
EUR	75	4-str	3		70.83	25.32	39.67	54.10	104.96			
EUR	76	4-str	3		114.60	20.06	51.54	70.92	262.01			
EUR	77	4-str	3		162.28	82.79	62.47	127.53	407.77			
EUR	78	4-str	3		75.49	21.15	26.92	57.41	250.05			
EUR	80	4-str	3		27.60	6.83	2.72	18.99	40.97			
EUR	81	4-str	3		139.73	34.40	45.42	125.15	478.89			
EUR	83	4-str	3		126.34	32.09	33.52	101.68	432.86			
EUR	137	4-str	3		25.88	7.16	86.37	73.70	37.88	77.99		
EUR	160	4-str	3			65.51	45.97	86.70	152.18	45.25		
JAPAN	26	4-str	3		155.63		38.48	130.64	502.61	43.45	114.40	26.34
JAPAN	64	4-str	3		20.43		13.12	8.24	14.30	2.20	18.36	2.07
USA	27	4-str	3				47.68	24.70	126.43			

Table 33: Results of the emissions validation tests for CO in g/test

region	no	engine type	max WMTC cycle part	max speed not reached	NEDC	ECE R 40	WMTC, part 1, cold	WMTC, part 2	WMTC, part 3	WMTC, part 1, hot	US-FTP	TRIAS
JAPAN	19	2-str	1	x			0.142			0.149	0.251	0.039
EUR	15	2-str	1			0.039	0.080			0.077		
EUR	42	2-str	1			0.023	0.047			0.030		
EUR	43	4-str	1			0.427	0.573			0.497		
EUR	46	4-str	1			0.290	0.563			0.437		
EUR	48	2-str	1			0.010	0.020			0.017		
EUR	50	2-str	1			0.030	0.037			0.030		
EUR	71	2-str	1			0.047	0.097			0.110		
EUR	72	2-str	1			0.020	0.047			0.020		
EUR	73	4-str	1		2.810	0.550	0.692					
EUR	79	2-str	1		5.590	1.720	1.608					
JAPAN	62	4-str	1				0.936			0.801	3.087	0.834
EUR	16	2-str	2	x		0.037	0.047	0.700		0.043		
EUR	17	4-str	2	x		0.270	0.253	2.207		0.230		
EUR	41	4-str	2	x		0.730	0.783	2.100		0.553		
EUR	51	4-str	2	x		0.533	0.630	1.510		0.350		
EUR	52	4-str	2	x		0.430	0.640	2.037		0.383		
JAPAN	63	4-str	2	x			0.641	2.188		0.500	1.444	0.510
EUR	7	4-str	2			0.919	1.245	2.673		0.756		
EUR	31	4-str	2		4.365	0.826	1.620	3.625		0.807		
EUR	34	4-str	2		1.681	0.519	0.748	1.348		0.451		
EUR	35	4-str	2		3.999	0.577	0.890	4.364		0.512		
EUR	47	4-str	2			0.609	0.893	2.950		0.843		
EUR	53	4-str	2			0.140	0.157	0.567		0.133		
EUR	54	4-str	2			0.433	0.530	2.570		0.487		
EUR	57	4-str	2			0.825	1.148	3.778	1.054			
EUR	67	4-str	2		3.675	0.666	1.665	3.745		0.757		
EUR	74	4-str	2		4.750	0.860	0.882	5.317				
EUR	82	2-str	2		0.288	0.206	0.223	0.347				
JAPAN	25	4-str	2				0.539	1.454		0.419	2.015	0.376
EUR	36	4-str	3	x	2.281	0.314	0.605	1.858	10.414	0.532		
USA	28	4-str	3	x			1.459	7.682	16.779			
EUR	13	4-str	3			0.412	1.628	2.609	7.438	0.712		
EUR	32	4-str	3		1.045	0.123	0.247	0.479	3.729	0.263		
EUR	38	4-str	3		1.209	0.188	0.437	1.226	4.130	0.358		
EUR	39	4-str	3		0.901	0.179	0.169	0.482	2.729	0.325		
EUR	40	4-str	3		2.087	0.230	0.351	0.992	10.820	0.360		
EUR	60	4-str	3			0.691	0.959	4.833	10.557	1.092		
EUR	65	4-str	3			0.557	0.597	2.817	16.440	0.627		
EUR	66	4-str	3		6.356	0.761	1.152	4.176	20.862	0.765		
EUR	68	4-str	3		0.172	0.087	0.252	0.277	0.763	0.204		
EUR	75	4-str	3		2.990	0.270	0.473	1.832	14.886			
EUR	76	4-str	3		1.140	0.160	0.352	1.039	5.373			
EUR	77	4-str	3		2.150	0.370	0.639	1.992	5.435			
EUR	78	4-str	3		2.920	0.450	0.717	2.975	9.712			
EUR	80	4-str	3		2.456	0.116	0.202	0.739	4.918			
EUR	81	4-str	3		2.631	0.604	0.846	2.332	5.734			
EUR	83	4-str	3		3.783	0.727	1.178	3.435	7.733			
EUR	137	4-str	3		1.843	0.264	0.486	1.643	6.546	0.399		
EUR	160	4-str	3			0.542	0.726	2.426	10.332	0.639		
JAPAN	26	4-str	3		4.792		1.955	4.352	8.196	1.158	5.766	0.939
JAPAN	64	4-str	3		2.023		0.509	1.177	7.835	0.310	1.988	0.310
USA	27	4-str	3				0.974	6.457	26.977			

Table 34: Results of the emissions validation tests for NOx in g/test

region	no	engine type	max WMTC cycle part	max speed not reached	NEDC	ECE R 40	WMTC, part 1, cold	WMTC, part 2	WMTC, part 3	WMTC, part 1, hot	US-FTP	TRIAS
JAPAN	19	2-str	1	x			176.6			184.9	477.9	180.3
EUR	15	2-str	1			179.6	169.3			171.9		
EUR	42	2-str	1			221.5	186.8			198.6		
EUR	43	4-str	1			176.8	182.6			169.0		
EUR	46	4-str	1			156.9	181.9			156.2		
EUR	48	2-str	1			139.8	145.9			131.9		
EUR	50	2-str	1			189.3	169.0			157.4		
EUR	71	2-str	1			139.3	133.9			128.1		
EUR	72	2-str	1			273.2	239.1			240.8		
EUR	73	4-str	1		699.0	293.6	289.1					
EUR	79	2-str	1		407.5	142.1	159.6					
JAPAN	62	4-str	1				90.4			85.8	259.8	91.7
EUR	16	2-str	2	x		192.9	176.2	483.8		155.0		
EUR	17	4-str	2	x		317.3	293.6	539.5		258.9		
EUR	41	4-str	2	x		221.7	203.4	439.5		184.4		
EUR	51	4-str	2	x		201.5	224.3	401.9		178.2		
EUR	52	4-str	2	x		193.8	204.2	414.1		188.6		
JAPAN	63	4-str	2	x			186.2	358.2		162.8	411.7	193.0
EUR	7	4-str	2			307.1	316.2	610.2		293.9		
EUR	31	4-str	2		797.0	313.8	303.4	602.4		276.9		
EUR	34	4-str	2		477.6	202.2	192.7	343.5		170.9		
EUR	35	4-str	2		654.5	262.0	245.5	470.8		183.8		
EUR	47	4-str	2			255.5	253.8	407.6		205.2		
EUR	53	4-str	2			178.9	180.4	369.0		157.0		
EUR	54	4-str	2			215.9	237.3	499.7		194.8		
EUR	57	4-str	2			291.7	305.0	501.8	271.4			
EUR	67	4-str	2		744.6	293.2	284.2	577.6		270.5		
EUR	74	4-str	2		644.7	235.2	178.0	443.6				
EUR	82	2-str	2		412.1	214.1	107.6	366.2				
JAPAN	25	4-str	2				285.1	443.1		246.2	696.2	315.9
EUR	36	4-str	3	x	604.1	268.0	254.2	391.5	945.3	220.7		
USA	28	4-str	3	x			670.3	1086.9	1913.6			
EUR	13	4-str	3			468.5	501.1	710.0	1374.4	398.7		
EUR	32	4-str	3		1644.5	790.9	690.6	1111.4	2062.9	670.2		
EUR	38	4-str	3		1295.0	672.0	574.6	864.1	1554.3	573.0		
EUR	39	4-str	3		1418.6	644.7	635.0	924.1	1629.1	523.2		
EUR	40	4-str	3		1533.7	783.4	733.1	998.2	1789.3	649.1		
EUR	60	4-str	3			637.2	579.0	888.4	1537.3	570.0		
EUR	65	4-str	3			692.5	596.4	933.7	1883.3	524.9		
EUR	66	4-str	3		1476.5	691.5	665.2	1053.2	2075.5	599.8		
EUR	68	4-str	3		1542.8	817.7	764.1	1003.5	1733.1	660.1		
EUR	75	4-str	3		1327.9	657.1	596.2	884.7	1600.3			
EUR	76	4-str	3		1183.4	556.6	596.7	857.3	1571.5			
EUR	77	4-str	3		830.4	336.4	353.1	577.8	1283.8			
EUR	78	4-str	3		719.1	320.4	259.1	490.1	1185.4			
EUR	80	4-str	3		1488.2	755.5	125.9	1034.3	1889.0			
EUR	81	4-str	3		590.3	235.6	224.7	404.2	890.8			
EUR	83	4-str	3		1055.5	493.0	476.2	684.3	1398.6			
EUR	137	4-str	3		929.7	464.4	355.9	539.3	1164.9	313.1		
EUR	160	4-str	3			566.3	441.2	690.3	1244.3	459.2		
JAPAN	26	4-str	3		953.2		418.2	632.2	1332.1	348.9	963.7	414.4
JAPAN	64	4-str	3		1425.7		699.4	1010.2	1857.9	626.6	1568.6	683.5
USA	27	4-str	3				463.9	789.4	1607.0			

Table 35: Results of the emissions validation tests for CO2 (measured values from the exhaust gas) in g/test

region	no	engine type	max WMTC cycle part	max speed not reached	NEDC	ECE R 40	WMTC, part 1, cold	WMTC, part 2	WMTC, part 3	WMTC, part 1, hot	US-FTP	TRIAS
JAPAN	19	2-str	1	x			4.006			2.347	2.387	2.105
EUR	15	2-str	1			7.787	10.158			5.413		
EUR	42	2-str	1			9.038	6.483			6.398		
EUR	43	4-str	1			0.828	0.880			0.781		
EUR	46	4-str	1			0.874	1.225			0.865		
EUR	48	2-str	1			28.709	13.441			14.118		
EUR	50	2-str	1			15.984	14.759			14.986		
EUR	71	2-str	1			16.647	12.444			13.960		
EUR	72	2-str	1			2.953	4.632			2.267		
EUR	73	4-str	1		0.781	0.727	0.691					
EUR	79	2-str	1		0.841	0.915	0.886					
JAPAN	62	4-str	1				0.902			0.760	0.708	0.698
EUR	16	2-str	2	x		14.533	10.054	7.489		9.234		
EUR	17	4-str	2	x		2.502	2.973	1.825		2.412		
EUR	41	4-str	2	x		1.897	2.490	2.064		2.131		
EUR	51	4-str	2	x		1.178	1.045	0.783		1.006		
EUR	52	4-str	2	x		1.491	1.962	1.371		1.435		
JAPAN	63	4-str	2	x			0.793	0.692		0.559	0.463	0.536
EUR	7	4-str	2			0.430	0.759	0.430		0.324		
EUR	31	4-str	2		0.536	0.339	0.770	0.333		0.200		
EUR	34	4-str	2		0.536	0.477	0.795	0.594		0.514		
EUR	35	4-str	2		0.873	1.281	1.004	0.763		1.069		
EUR	47	4-str	2			0.500	0.694	0.495		0.504		
EUR	53	4-str	2			2.050	2.881	1.693		1.795		
EUR	54	4-str	2			0.909	1.170	0.584		0.768		
EUR	57	4-str	2			1.419	1.831	0.888	1.364			
EUR	67	4-str	2		0.454	0.191	0.699	0.286		0.168		
EUR	74	4-str	2		1.429	3.178	2.864	1.523				
EUR	82	2-str	2		3.757	1.077	7.233	3.789				
JAPAN	25	4-str	2				0.711	0.504		0.604	0.469	0.247
EUR	36	4-str	3	x	0.534	0.593	0.715	0.520	0.466	0.461		
USA	28	4-str	3	x			2.875	0.594	0.400			
EUR	13	4-str	3			0.552	0.881	0.378	0.301	0.498		
EUR	32	4-str	3		0.543	0.131	1.553	0.174	0.103	0.465		
EUR	38	4-str	3		0.454	0.170	1.533	0.160	0.044	0.250		
EUR	39	4-str	3		0.471	0.367	1.003	0.413	0.689	1.350		
EUR	40	4-str	3		0.388	0.282	0.456	0.232	0.226	0.501		
EUR	60	4-str	3			1.217	2.328	0.891	0.734	1.566		
EUR	65	4-str	3			2.244	2.657	1.003	0.523	1.563		
EUR	66	4-str	3		0.447	0.168	1.313	0.206	0.174	0.251		
EUR	68	4-str	3		0.081	0.029	0.204	0.018	0.029	0.090		
EUR	75	4-str	3		0.734	0.819	1.091	0.663	0.720			
EUR	76	4-str	3		0.378	0.232	0.593	0.347	0.422			
EUR	77	4-str	3		0.994	1.557	1.432	1.041	0.649			
EUR	78	4-str	3		1.029	1.790	1.730	1.398	0.705			
EUR	80	4-str	3		0.439	0.313	0.100	0.376	0.358			
EUR	81	4-str	3		0.638	0.757	1.606	0.642	0.438			
EUR	83	4-str	3		0.821	0.617	1.065	0.734	0.497			
EUR	137	4-str	3		0.163	0.115	0.900	0.403	0.167	0.581		
EUR	160	4-str	3			1.345	1.453	0.963	0.452	1.159		
JAPAN	26	4-str	3		0.721		1.498	0.860	0.529	0.621	0.846	0.653
JAPAN	64	4-str	3		0.384		0.782	0.424	0.333	0.284	0.402	0.277
USA	27	4-str	3				4.434	0.899	0.438			

Table 36: Results of the emissions validation tests for HC in g/km

region	no	engine type	max WMTC cycle part	max speed not reached	NEDC	ECE R 40	WMTC, part 1, cold	WMTC, part 2	WMTC, part 3	WMTC, part 1, hot	US-FTP	TRIAS
JAPAN	19	2-str	1	x			5.62			4.74	5.72	4.24
EUR	15	2-str	1			11.59	10.42			9.92		
EUR	42	2-str	1			17.92	15.12			14.74		
EUR	43	4-str	1			14.22	14.22			14.50		
EUR	46	4-str	1			13.28	12.77			13.87		
EUR	48	2-str	1			40.73	32.01			31.88		
EUR	50	2-str	1			33.43	30.50			29.85		
EUR	71	2-str	1			29.25	24.64			24.71		
EUR	72	2-str	1			11.95	9.56			12.22		
EUR	73	4-str	1		10.99	4.55	6.65					
EUR	79	2-str	1		0.67	0.48	0.71					
JAPAN	62	4-str	1				5.28			6.03	5.21	5.64
EUR	16	2-str	2	x		27.75	21.35	15.26		21.30		
EUR	17	4-str	2	x		42.63	40.71	32.28		43.06		
EUR	41	4-str	2	x		9.65	14.52	20.41		13.72		
EUR	51	4-str	2	x		15.78	13.94	22.85		17.12		
EUR	52	4-str	2	x		10.82	13.70	18.05		13.35		
JAPAN	63	4-str	2	x			10.22	13.91		11.66	10.17	9.95
EUR	7	4-str	2			3.28	3.75	6.99		3.73		
EUR	31	4-str	2		3.73	0.84	1.69	2.94		1.03		
EUR	34	4-str	2		11.08	3.17	5.32	11.22		5.43		
EUR	35	4-str	2		8.89	7.15	7.24	6.11		9.88		
EUR	47	4-str	2			9.55	7.75	10.06		9.05		
EUR	53	4-str	2			31.93	34.59	28.83		30.11		
EUR	54	4-str	2			15.48	16.19	12.09		17.05		
EUR	57	4-str	2			7.50	6.49	7.20	5.90			
EUR	67	4-str	2		4.79	0.82	1.95	3.34		1.15		
EUR	74	4-str	2		6.85	5.90	7.35	6.94				
EUR	82	2-str	2		4.04	0.63	7.40	13.66				
JAPAN	25	4-str	2				7.41	15.96		8.19	8.77	4.91
EUR	36	4-str	3	x	16.14	15.63	15.62	13.32	13.47	13.08		
USA	28	4-str	3	x			15.91	2.73	13.81			
EUR	13	4-str	3			4.32	5.95	3.99	5.50	4.68		
EUR	32	4-str	3		4.90	1.71	13.78	2.41	1.21	5.20		
EUR	38	4-str	3		7.80	3.91	20.34	2.67	1.97	5.21		
EUR	39	4-str	3		3.83	0.49	6.21	3.58	10.27	4.66		
EUR	40	4-str	3		1.36	1.16	2.58	0.86	0.56	1.19		
EUR	60	4-str	3			1.22	3.02	1.40	4.99	1.38		
EUR	65	4-str	3			7.13	8.12	4.10	3.19	7.08		
EUR	66	4-str	3		1.95	0.75	4.49	1.02	0.81	0.97		
EUR	68	4-str	3		0.39	0.17	0.84	0.08	0.19	0.34		
EUR	75	4-str	3		6.59	6.42	9.77	5.93	6.66			
EUR	76	4-str	3		10.64	5.12	12.71	7.76	16.63			
EUR	77	4-str	3		15.13	21.07	15.40	14.03	25.97			
EUR	78	4-str	3		7.04	5.45	6.58	6.30	15.91			
EUR	80	4-str	3		2.55	1.72	0.67	2.09	2.61			
EUR	81	4-str	3		12.92	8.67	11.19	13.76	30.85			
EUR	83	4-str	3		11.69	8.10	8.29	11.15	27.45			
EUR	137	4-str	3		2.40	1.83	21.45	8.11	2.41	19.38		
EUR	160	4-str	3			16.09	11.24	9.47	9.69	11.02		
JAPAN	26	4-str	3		14.13		9.47	14.34	31.95	10.70	9.53	6.60
JAPAN	64	4-str	3		1.85		3.23	0.90	0.91	0.54	1.53	0.52
USA	27	4-str	3				11.73	2.71	8.08			

Table 37: Results of the emissions validation tests for CO in g/km

region	no	engine type	max WMTC cycle part	max speed not reached	NEDC	ECE R 40	WMTC, part 1, cold	WMTC, part 2	WMTC, part 3	WMTC, part 1, hot	US-FTP	TRIAS
JAPAN	19	2-str	1	x			0.035			0.037	0.023	0.010
EUR	15	2-str	1			0.010	0.020			0.019		
EUR	42	2-str	1			0.006	0.011			0.007		
EUR	43	4-str	1			0.107	0.142			0.122		
EUR	46	4-str	1			0.073	0.138			0.108		
EUR	48	2-str	1			0.003	0.005			0.004		
EUR	50	2-str	1			0.008	0.009			0.007		
EUR	71	2-str	1			0.012	0.024			0.027		
EUR	72	2-str	1			0.005	0.012			0.005		
EUR	73	4-str	1		0.260	0.139	0.169					
EUR	79	2-str	1		0.558	0.433	0.394					
JAPAN	62	4-str	1				0.234			0.200	0.285	0.209
EUR	16	2-str	2	x		0.009	0.012	0.080		0.011		
EUR	17	4-str	2	x		0.067	0.062	0.247		0.056		
EUR	41	4-str	2	x		0.183	0.193	0.236		0.139		
EUR	51	4-str	2	x		0.134	0.154	0.168		0.086		
EUR	52	4-str	2	x		0.108	0.158	0.229		0.094		
JAPAN	63	4-str	2	x			0.158	0.243		0.123	0.133	0.128
EUR	7	4-str	2			0.230	0.311	0.295		0.186		
EUR	31	4-str	2		0.416	0.209	0.397	0.397		0.198		
EUR	34	4-str	2		0.159	0.132	0.185	0.149		0.111		
EUR	35	4-str	2		0.382	0.146	0.221	0.483		0.126		
EUR	47	4-str	2			0.152	0.219	0.325		0.208		
EUR	53	4-str	2			0.035	0.039	0.062		0.033		
EUR	54	4-str	2			0.109	0.131	0.283		0.120		
EUR	57	4-str	2			0.203	0.293	0.414	0.258			
EUR	67	4-str	2		0.346	0.167	0.408	0.412		0.186		
EUR	74	4-str	2		0.450	0.218	0.218	0.585				
EUR	82	2-str	2		0.028	0.052	0.055	0.041				
JAPAN	25	4-str	2				0.133	0.159		0.103	0.168	0.094
EUR	36	4-str	3	x	0.213	0.080	0.150	0.205	0.665	0.131		
USA	28	4-str	3	x			0.359	0.844	1.071			
EUR	13	4-str	3			0.103	0.400	0.286	0.475	0.173		
EUR	32	4-str	3		0.098	0.031	0.061	0.053	0.237	0.065		
EUR	38	4-str	3		0.112	0.049	0.108	0.135	0.263	0.088		
EUR	39	4-str	3		0.084	0.046	0.042	0.053	0.173	0.081		
EUR	40	4-str	3		0.194	0.059	0.087	0.110	0.688	0.089		
EUR	60	4-str	3			0.170	0.235	0.528	0.669	0.267		
EUR	65	4-str	3			0.137	0.144	0.307	1.043	0.150		
EUR	66	4-str	3		0.578	0.193	0.284	0.459	1.326	0.187		
EUR	68	4-str	3		0.016	0.022	0.063	0.031	0.049	0.050		
EUR	75	4-str	3		0.278	0.068	0.116	0.201	0.945			
EUR	76	4-str	3		0.106	0.041	0.087	0.114	0.341			
EUR	77	4-str	3		0.200	0.094	0.157	0.219	0.346			
EUR	78	4-str	3		0.272	0.116	0.175	0.326	0.618			
EUR	80	4-str	3		0.227	0.029	0.050	0.081	0.313			
EUR	81	4-str	3		0.243	0.152	0.208	0.256	0.369			
EUR	83	4-str	3		0.350	0.183	0.291	0.377	0.490			
EUR	137	4-str	3		0.171	0.067	0.121	0.181	0.416	0.099		
EUR	160	4-str	3			0.133	0.177	0.265	0.658	0.156		
JAPAN	26	4-str	3		0.435		0.482	0.478	0.521	0.285	0.480	0.235
JAPAN	64	4-str	3		0.184		0.125	0.129	0.497	0.076	0.166	0.078
USA	27	4-str	3				0.239	0.708	1.724			

Table 38: Results of the emissions validation tests for NOx in g/km

region	no	engine type	max WMTC cycle part	max speed not reached	NEDC	ECE R 40	WMTC, part 1, cold	WMTC, part 2	WMTC, part 3	WMTC, part 1, hot	US-FTP	TRIAS
JAPAN	19	2-str	1	x			43.6			45.6	43.9	45.2
EUR	15	2-str	1			44.9	41.3			42.2		
EUR	42	2-str	1			55.6	45.6			48.6		
EUR	43	4-str	1			44.2	45.2			41.6		
EUR	46	4-str	1			39.3	44.7			38.6		
EUR	48	2-str	1			35.0	36.2			32.5		
EUR	50	2-str	1			47.6	41.4			38.7		
EUR	71	2-str	1			34.9	33.1			31.6		
EUR	72	2-str	1			68.7	59.2			59.7		
EUR	73	4-str	1		64.7	74.1	70.7					
EUR	79	2-str	1		40.7	35.8	39.1					
JAPAN	62	4-str	1				22.7			21.4	24.0	23.0
EUR	16	2-str	2	x		48.3	43.5	55.0		37.9		
EUR	17	4-str	2	x		79.1	72.2	60.4		63.3		
EUR	41	4-str	2	x		55.5	50.2	49.3		46.3		
EUR	51	4-str	2	x		50.5	54.9	44.8		43.8		
EUR	52	4-str	2	x		48.5	50.3	46.5		46.1		
JAPAN	63	4-str	2	x			45.9	39.8		40.1	38.0	48.3
EUR	7	4-str	2			76.9	79.1	67.4		72.5		
EUR	31	4-str	2		76.0	79.2	74.4	66.0		67.8		
EUR	34	4-str	2		45.2	51.3	47.7	37.9		42.1		
EUR	35	4-str	2		62.5	66.5	61.0	52.1		45.3		
EUR	47	4-str	2			63.9	62.3	44.8		50.5		
EUR	53	4-str	2			44.8	44.4	40.7		38.7		
EUR	54	4-str	2			54.1	58.4	54.9		47.8		
EUR	57	4-str	2			71.6	77.9	55.0	66.5			
EUR	67	4-str	2		70.1	73.4	69.7	63.5		66.4		
EUR	74	4-str	2		61.1	59.6	44.1	48.8				
EUR	82	2-str	2		40.4	53.8	26.7	42.9				
JAPAN	25	4-str	2			79.0	70.4	48.6		60.6	58.1	79.0
EUR	36	4-str	3	x	56.3	67.8	62.9	43.1	60.3	54.5		
USA	28	4-str	3	x			164.7	119.4	122.1			
EUR	13	4-str	3			117.4	123.0	77.9	87.7	97.0		
EUR	32	4-str	3		153.8	201.8	170.8	122.3	131.1	164.7		
EUR	38	4-str	3		120.3	173.8	142.8	94.9	98.8	141.3		
EUR	39	4-str	3		131.8	164.8	157.2	101.6	103.5	130.2		
EUR	40	4-str	3		142.8	200.1	181.3	110.5	113.8	159.8		
EUR	60	4-str	3			156.9	142.0	97.1	97.5	139.5		
EUR	65	4-str	3			170.1	143.5	101.7	119.5	125.3		
EUR	66	4-str	3		134.2	175.9	163.9	115.7	131.9	146.8		
EUR	68	4-str	3		143.3	210.9	190.5	110.6	110.3	162.5		
EUR	75	4-str	3		123.5	166.7	146.8	97.0	101.6			
EUR	76	4-str	3		109.9	142.0	147.1	93.8	99.8			
EUR	77	4-str	3		77.4	85.6	87.0	63.6	81.8			
EUR	78	4-str	3		67.1	82.5	63.3	53.8	75.4			
EUR	80	4-str	3		137.4	190.8	31.1	113.8	120.2			
EUR	81	4-str	3		54.6	59.4	55.4	44.4	57.4			
EUR	83	4-str	3		97.7	124.4	117.8	75.1	88.7			
EUR	137	4-str	3		86.1	118.6	88.4	59.4	74.0	77.8		
EUR	160	4-str	3			139.0	107.8	75.4	79.2	111.9		
JAPAN	26	4-str	3		86.5		103.0	69.4	84.7	85.9	80.3	103.8
JAPAN	64	4-str	3		129.4		172.0	110.7	117.9	154.1	130.8	171.2
USA	27	4-str	3				114.1	86.5	102.7			

Table 39: Results of the emissions validation tests for CO2 (measured values from the exhaust gas) in g/km

10. TEST PROTOCOL

An update of the test protocol was worked out on the basis of the state of the discussion in the WMTC group so far and on the basis of the ISO work on updating ISO 11486 (Motorcycles - Chassis dynamometer setting method) and ISO 6460 (concerning the gas sampling and cooling aspects). This protocol was used for the preparation of the round robin test. It can now be replaced by the draft global technical regulation.

11. ROUND ROBIN TEST

The round robin test was started in April 2003. Three vehicles (one per class) were tested in different laboratories in all three regions. The aim is to get experience about the interpretation / application of the WMTC test procedure in different laboratories and to get reliable data for the calculation of the reproducibility of the WMTC test procedure.

Eight laboratories were participated in the round robin test, one from Japan, one from the USA and six from Europe. The results of the WMTC tests are shown in Table 40. Table 41 shows the results for the ECE Regulation No. 40 test. Large differences were found between the laboratories for both cycles.

The test result deviations were examined in detail, but examination could not be applied to the ECE cycle test results due to the fact that measurement was done only once in the ECE cycle round robin test.

Average of the three test performed in each lab

WMTC

		PART 1								Average value	Correlation amongst all labs: Deviation %								Standard Deviation	Variation coefficient
		Lab.A	Lab.B	Lab.C	Lab.D	Lab.E	Lab.F	Lab.G	Lab.H		Lab.A	Lab.B	Lab.C	Lab.D	Lab.E	Lab.F	Lab.G	Lab.H		
CO (g/km)	CLASS1	6.94	5.77	7.12	8.04	6.38	8.92	7.51	8.27	**7.37**	-6%	-22%	-3%	9%	-13%	21%	2%	12%	1.03	14%
	CLASS2	6.26	4.22	4.17	6.07	6.85	5.41	4.87	6.95	**5.60**	12%	-25%	-26%	8%	22%	-3%	-13%	24%	1.11	20%
	CLASS3	14.22	14.01	15.24	20.40	13.55	15.31	15.30	15.94	**15.50**	-8%	-10%	-2%	32%	-13%	-1%	-1%	3%	2.14	14%
HC (g/km)	CLASS1	1.48	1.19	1.51	1.21	0.97	1.67	1.08	1.45	**1.32**	12%	-10%	15%	-8%	-27%	27%	-18%	10%	0.24	18%
	CLASS2	0.90	0.58	1.19	0.78	0.96	1.36	0.47	1.14	**0.92**	-3%	-37%	29%	-15%	4%	47%	-49%	24%	0.30	33%
	CLASS3	2.28	1.86	1.99	2.58	2.03	2.33	2.27	2.23	**2.20**	4%	-16%	-9%	18%	-7%	6%	3%	2%	0.23	10%
NOx (g/km)	CLASS1	0.35	0.43	0.33	0.41	0.34	0.36	0.34	0.39	**0.37**	-4%	17%	-12%	11%	-7%	-3%	-7%	6%	0.04	10%
	CLASS2	0.19	0.23	0.21	0.22	0.23	0.28	0.17	0.22	**0.22**	-15%	7%	-5%	-1%	6%	29%	-24%	2%	0.03	16%
	CLASS3	0.40	0.43	0.35	0.41	0.39	0.41	0.37	0.40	**0.39**	1%	9%	-11%	3%	-2%	3%	-5%	3%	0.02	6%
CO2 (g/km)	CLASS1	69.09	74.13	61.65	69.48	79.54	73.34	71.15	72.39	**71.34**	-3%	4%	-14%	-3%	11%	3%	0%	1%	5.11	7%
	CLASS2	53.98	55.51	47.97	50.80	66.64	62.57	50.60	61.79	**56.23**	-4%	-1%	-15%	-10%	19%	11%	-10%	10%	6.70	12%
	CLASS3	143.36	148.63	136.14	144.55	162.00	155.65	158.66	156.63	**150.70**	-5%	-1%	-10%	-4%	7%	3%	5%	4%	8.94	6%

(*) Part1-hot for Peugeot

		PART 1								Average value	Deviation %								Standard Deviation	Variation coefficient
		Lab.A	Lab.B	Lab.C	Lab.D	Lab.E	Lab.F	Lab.G	Lab.H		Lab.A	Lab.B	Lab.C	Lab.D	Lab.E	Lab.F	Lab.G	Lab.H		
CO (g/km)	CLASS1	4.81	3.46	5.51	6.38	3.94	5.94	5.14	5.48	**5.08**	-5%	-32%	8%	26%	-22%	17%	1%	8%	0.98	19%
	CLASS2	14.26	11.64	7.77	8.61	9.62	11.22	10.28	11.98	**10.67**	34%	9%	-27%	-19%	-10%	5%	-4%	12%	2.06	19%
	CLASS3	2.92	2.30	3.03	3.38	2.39	2.30	3.57	3.26	**2.89**	1%	-21%	5%	17%	-17%	-21%	24%	13%	0.51	18%
HC (g/km)	CLASS1	0.88	0.89	0.91	0.81	0.60	0.96	0.75	0.87	**0.83**	6%	7%	9%	-3%	-28%	15%	-10%	4%	0.11	14%
	CLASS2	0.71	0.52	0.79	0.56	0.69	1.02	0.51	0.88	**0.71**	0%	-27%	11%	-21%	-3%	43%	-28%	24%	0.18	25%
	CLASS3	0.48	0.48	0.48	0.50	0.42	0.57	0.51	0.49	**0.49**	-2%	-2%	-2%	2%	-15%	15%	4%	-1%	0.04	8%
NOx (g/km)	CLASS1	0.36	0.44	0.31	0.43	0.35	0.33	0.36	0.38	**0.37**	-4%	19%	-15%	16%	-5%	-11%	-2%	2%	0.04	12%
	CLASS2	0.25	0.30	0.32	0.39	0.31	0.36	0.29	0.34	**0.32**	-20%	-7%	-1%	23%	-3%	13%	-11%	5%	0.04	14%
	CLASS3	0.92	1.09	0.76	0.99	0.77	0.95	0.84	0.97	**0.91**	0%	20%	-17%	9%	-15%	4%	-7%	7%	0.11	13%
CO2 (g/km)	CLASS1	69.86	72.55	61.50	68.20	80.00	73.77	72.55	72.26	**71.34**	-2%	2%	-14%	-4%	12%	3%	2%	1%	5.26	7%
	CLASS2	45.88	47.04	43.13	45.24	52.63	51.84	46.05	50.96	**47.85**	-4%	-2%	-10%	-5%	10%	8%	-4%	7%	3.49	7%
	CLASS3	101.28	104.76	94.07	103.20	106.59	107.10	111.38	106.11	**104.31**	-3%	0%	-10%	-1%	2%	3%	7%	2%	5.09	5%

		PART 1								Average value	Deviation %								Standard Deviation	Variation coefficient
		Lab.A	Lab.B	Lab.C	Lab.D	Lab.E	Lab.F	Lab.G	Lab.H		Lab.A	Lab.B	Lab.C	Lab.D	Lab.E	Lab.F	Lab.G	Lab.H		
CO (g/km)	CLASS3	10.60		7.15	6.44	3.62	5.35	17.46	7.47	**8.69**	22%	n.a.	-18%	-26%	-58%	-38%	101%	-14%	5.53	64%
HC (g/km)	CLASS3	0.37		0.31	0.31	0.24	0.34	0.52	0.33	**0.35**	4%	n.a.	-12%	-14%	-32%	-5%	46%	-7%	0.10	29%
NOx (g/km)	CLASS3	1.12		1.07	1.45	1.35	1.33	0.76	1.32	**1.20**	-7%	n.a.	-11%	20%	12%	11%	-37%	10%	0.27	23%
CO2 (g/km)	CLASS3	108.33		102.48	109.40	114.30	114.68	110.87	118.37	**111.52**	-3%	n.a.	-8%	-2%	2%	3%	-1%	6%	2.87	3%

=> deviation 5% -:- 10%
=> deviation > 10%
=> deviation > 20%
=> Not tested

B & G excluded

NB: only minimum and maximum deviation indicated

B & G excluded

Table 40: Results of the round robin test for the WMTC cycle

1 test each lab; D & CH = 2 test av., JRC = 3 test av.

2002/51/EC

		Final emissions							Average value	Correlation amongst all European labs								
										Deviation %							Standard Deviation	Variation coefficient
		Lab.A	Lab.B	Lab.C	Lab.D	Lab.E	Lab.F	Lab.H		Lab.A	Lab.B	Lab.C	Lab.D	Lab.E	Lab.F	Lab.H		
CO (g/km)	CALSS1	3.81	3.64	5.40	5.61	3.29	4.93	5.17	**4.55**	-16%	-20%	**19%**	23%	**-28%**	8%	14%	0.94	**21%**
	CALSS2	7.03	4.93	5.14	7.37	7.13	5.24	7.29	**6.30**	11%	-22%	-19%	17%	13%	-17%	16%	1.13	18%
	CLASS3	5.80	3.62	6.03	7.40	5.29	4.14	6.01	**5.47**	6%	**-34%**	10%	**35%**	-3%	**-24%**	10%	1.27	**23%**
HC (g/km)	CALSS1	0.77	0.87	0.99	0.83	0.56	0.89	0.84	**0.82**	-6%	5%	**20%**	1%	**-32%**	8%	3%	0.13	16%
	CALSS2	1.25	0.98	1.50	0.45	1.33	1.45	1.32	**1.18**	6%	**-17%**	27%	**-62%**	12%	22%	12%	0.36	31%
	CLASS3	1.60	1.61	1.05	1.39	1.12	1.26	0.96	**1.28**	**25%**	**25%**	-18%	**9%**	-13%	-2%	**-25%**	0.26	**20%**
NOx (g/km)	CALSS1	0.27	0.37	0.27	0.29	0.31	0.32	0.26	**0.30**	-8%	**24%**	-8%	**-2%**	4%	6%	-15%	0.04	13%
	CALSS2	0.13	0.18	0.14	0.10	0.13	0.22	0.16	**0.15**	-14%	19%	-6%	-32%	**-17%**	**46%**	4%	0.04	**26%**
	CLASS3	0.18	0.27	0.25	0.13	0.23	0.30	0.24	**0.23**	**-20%**	19%	9%	-44%	-2%	**33%**	4%	0.06	25%
CO2 (g/km)	CALSS1	74.54	78.15	65.07	74.20	89.60	80.05	77.00	**76.95**	-3%	2%	-15%	-4%	16%	4%	0%	7.37	10%
	CALSS2	62.44	66.33	58.43	57.60	71.90	70.63	69.70	**65.29**	-4%	2%	-11%	-12%	10%	8%	7%	5.88	9%
	CLASS3	152.20	154.51	159.21	151.10	185.60	173.97	169.90	**163.78**	-7%	-6%	-3%	-8%	13%	6%	4%	13.03	8%

=> deviation 5% -:- 10%
=> deviation > 10%
=> deviation > 20%
NB: only minimum and maximum deviation indicated

<u>Table</u> 41: Results of the round robin test for the ECE Regulation No. 40 cycle

The following findings were obtained from the results of the round robin test and its analysis:

a) The salient outcome of the test was large differences in test results for the WMTC as well as for the ECE Regulation No. 40 among the laboratories that had performed the test.

b) The one-way layout variance analysis of WMTC test results showed the following :
- There was no significant difference in repeatability (variance) among the laboratories.
- There was difference in test results among the laboratories.

c) The multiple regression analysis of WMTC test results and velocity traceability resulted in the following conclusions:
- Some of the laboratories failed to keep velocity traceability errors within the tolerance established in the WMTC.
- In many cases, there was a correlation between THC emission amount and velocity traceability.
- In addition to velocity traceability, the emission measurement system including the setting of the chassis dynamometer may be considered as an influencing factor for emission test results.

d) The analysis of emission concentration in time series of laboratories recording different velocity traceability performances resulted in:
- With the WMTC, THC emission behaviour differed when velocity traceability performances differed.
- There were differences in total carbon concentration among the laboratories, and these differences may be attributable to discrepancies in the calibration of the emission measurement system including the setting of the chassis dynamometer.

e) The possible influence of vehicle condition on emission behaviour was suggested by NOx and other emission patterns, hut the available data were not sufficient to allow effective analysis on this possibility.

Data needed to evaluate correlations among laboratories

The discrepancies in the test results of laboratories may be corrected by the methods listed below. These methods will need to be implemented by each laboratory in order to improve its measurement accuracy.

a) Errors in the measurement system:
- Chassis dynamometer:
  Removal of systematic errors: Examination into running resistance (examination of dynamo load meter and coast down time);
  Removal of accidental errors: Repetition testing (already in action).
- Exhaust system.

Removal of systematic errors: Calibrate the emission measurement system by propane shooting prior to a round robin test. Additionally, calibrate the emission measurement system by span gas shooting after each round of the test.
Removal of accidental errors: Repetition testing (already in action).

b) Change in vehicle condition:
After setting the running resistance, measure the emission amount (g/km) at idle and constant speeds (for example, at 40, 60, 80, 100 and 120 km/h), and find out changes in the vehicle condition and errors in the emission measurement system.
Removal of systematic errors: Respect the test protocol, and set uniform testing conditions such as temperature, humidity and cooling wind direction and other conditions.
Removal of accidental errors: Drive the test vehicle at least two cycles before starting the test.

c) Running method:
Consider the methods listed below, assuming the driving of the test vehicle within the tolerance established in the test method.
Removal of systematic errors: Use the same rider throughout the test.
Removal of accidental errors: Repetition testing (already in action).

12. OFF CYCLE EMISSIONS

The discussion has already been started, but this issue is subject of future work. Generic aspects and definitions that are worked out in the parallel working HDV-Off Cycle emission group (GRPE informal group) will be considered for the discussions in the WMTC group.

13. SUMMARY AND CONCLUSIONS

The developed test cycle and the accompanying gearshift procedure were tested in several laboratories in all three regions with respect to driveability. They form a good balance between representativity of in-use driving and bench test requirements like reproducibility. The dynamics of the WMTC cycle reflect the average driving behaviour for motorcycles in real live operation. The final result of the cycle development is cycle version 9 with 3 parts and two versions per part (normal and reduced speed).

The road load settings and other test conditions like cooling fan specifications were updated according to the outcome of the ISO work.

Although the requirements of the emissions validation programme were not fully met, there are enough valid results left for future analysis. All current reduction systems are represented in the vehicle sample; reduction systems were a bit underrepresented in provisional class 2, whereas the major part of the provisional class 3 vehicles was equipped with reductions systems. The major part of the emissions validation test results can be used for a comparison with regional emissions test procedures.

The round robin test is finalised. The salient outcome of the test was large differences in test results for the WMTC as well as for the ECE Regulation No. 40 among the laboratories that had performed the test. These differences need to be reduced. Some recommendations were given how to achieve this.

The compromises found for vehicle classification and weighting of the results are well balanced between the different requirements like representativity, practicability and simplicity.

With the developed test cycle, gearshift prescriptions and test protocol a world wide harmonized emissions test procedure for motorcycles can be established. A draft version of a global technical regulation has already been worked out. The only issue that needs to be clarified is the performance requirements.

14. LITERATURE

[1] R R.C. Rijkeboer:
WMTC – Final report, TNO Report 01.OR.VM.034.1/RR, by order of the Netherlands Ministry of the Environment (VROM), May 2001

[2] F. Schröder:
"Betriebsweise, Emissionen und Kraftstoffverbrauch von Motorrädern". Thesis of the Technical University Darmstadt. Published as part of the series Fortschritt-Berichte VDI, Reihe 12, Nr. 435, May 2000

[3] ISO TC22 SC22 WG17:
"Expert proposals on the four technical aspects to WMTC FE". April 2002

[4] Draft global technical regulation (gtr) on uniform provisions concerning the measurement procedure for motorcycles equipped with a positive-ignition engine with regard to the emission of gaseous pollutants, CO2 emissions and fuel consumption by the engine (TRANS/WP.29/GRPE/2004/11)

[5] JARI:
Presentation material for the WMTC group related to in-use data analysis with respect to cycle development work, dealing with statistical distributions of vehicle speed, idling time, trip length, acceleration, deceleration and cruising phases, 2000 to 2001

[6] M. Akai:
"Analysis of the Candidate Cycles for the WMTC activities", Japan Automobile Research Institute, 02. April 2001

[7] JARI:
"Analysis of WMTC Round Robin Test Results" (Draft), Japan Automobile Research Institute, 17. December 2003, WMTC-2004-143

15. ANNEX A

DESCRIPTION OF THE MODIFICATION WORK ON THE WMTC CYCLE

The following modifications were carried out based on technical discussions in the WMTC group and preliminary tests by the industry.

TNO Automotive did first modifications on the WMTC cycle that are mainly related to the improvement of the driveability. These modifications concern cycle parts below 20 km/h, the smoothing of ripples for the cruising parts caused by vehicle speed measurement uncertainties and the maximum speed of part 3 of the cycle. A detailed description of these modifications is given in [1].

The resulting cycle was named "version 3" and is shown in Table 42 to Table 44
Table 44.

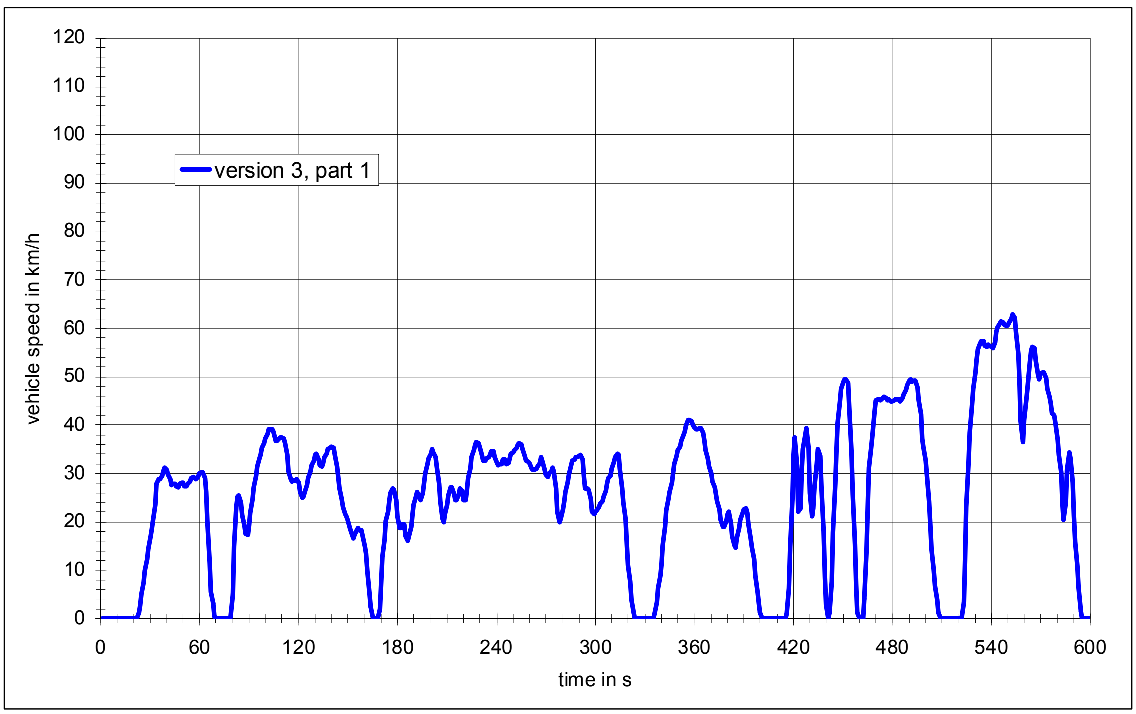

Table 42: Cycle version 3, part 1

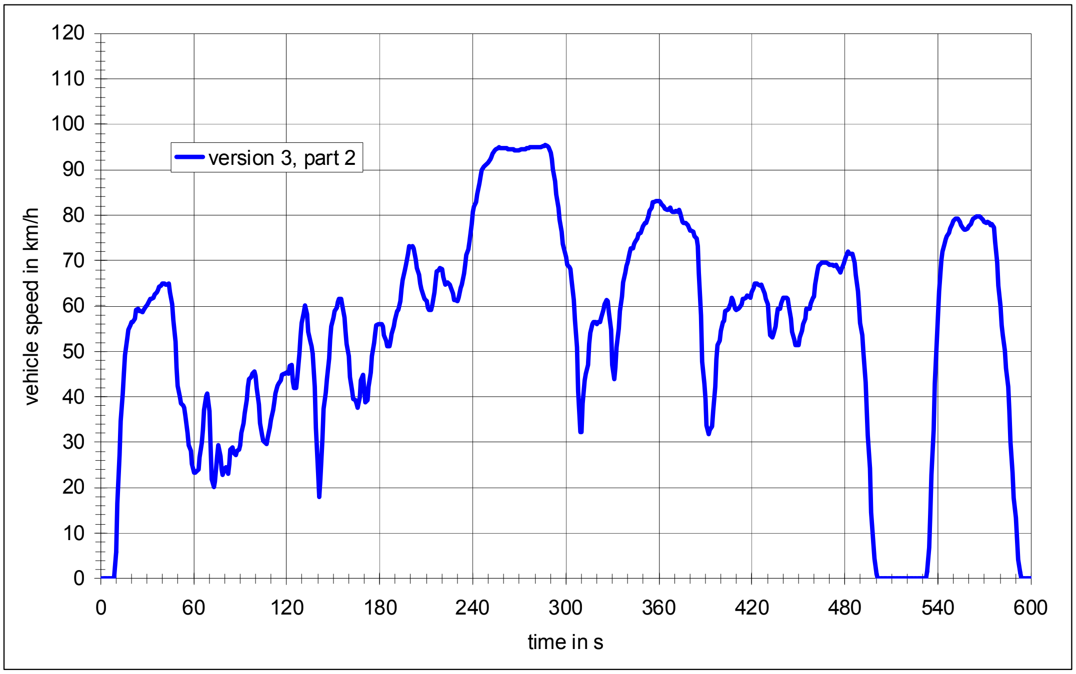

Table 43: Cycle version 3, part 2

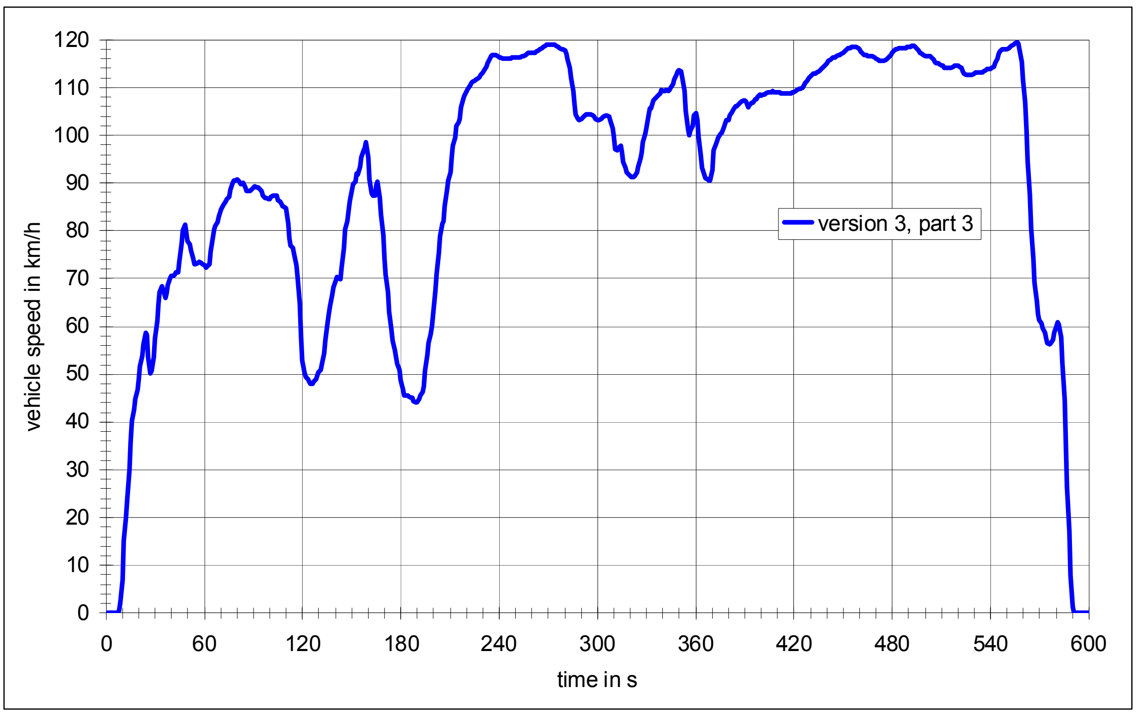

Table 44: Cycle version 3, part 3

RWTUEV Fahrzeug carried out further modifications on the basis of discussions and decisions in the WMTC group.

The following modifications were done in a second step:

Part 1:

- Modules 2, 3 and 5 of part 1 were replaced by more representative ones (length, average speed and dynamics were kept),
- The rank order of the modules was changed (module 8 was shifted to the 2nd position),
- The top speed of module 8 was limited to 60 km/h,
- The idle time distribution was brought in line with the statistics.

Part 3:

- The top speed was increased to 125 km/h.

These modifications resulted in version 4.

Furthermore an analysis of the acceleration pattern showed unrealistic "jumps" in some cycle phases. Smoothing the acceleration pattern and recalculating the vehicle speed pattern from the smoothed acceleration pattern eliminated these "jumps". This results in version 5. Version 5 was used for the driveability validation tests and is shown in Table 45 to Table 47.

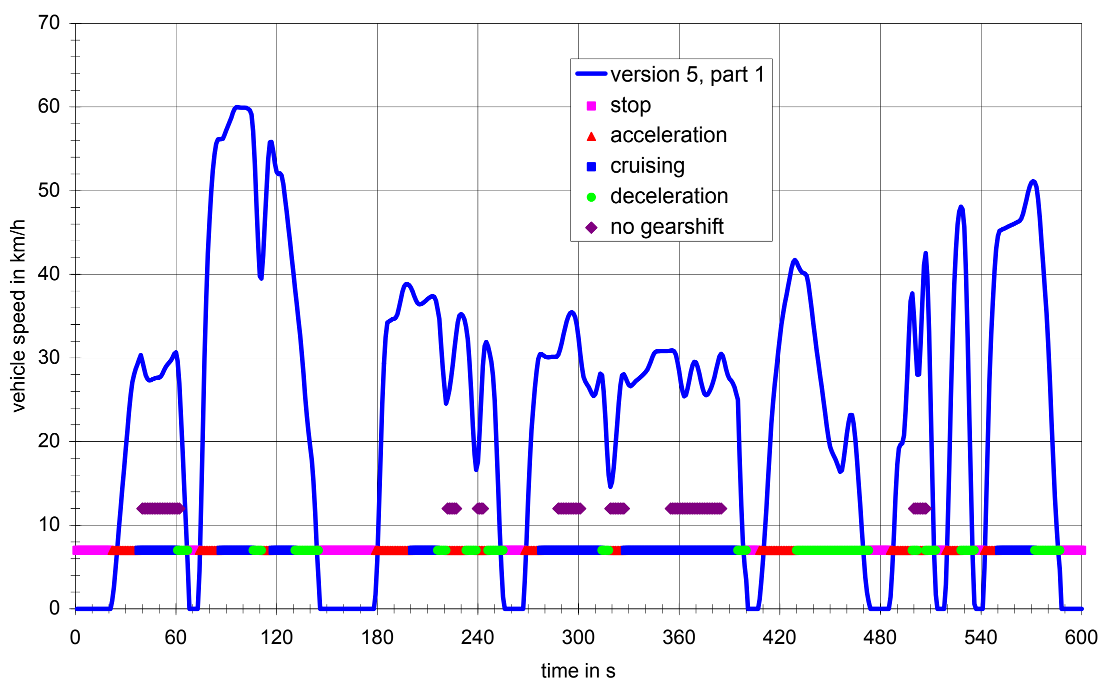

Table 45: Cycle version 5, part 1

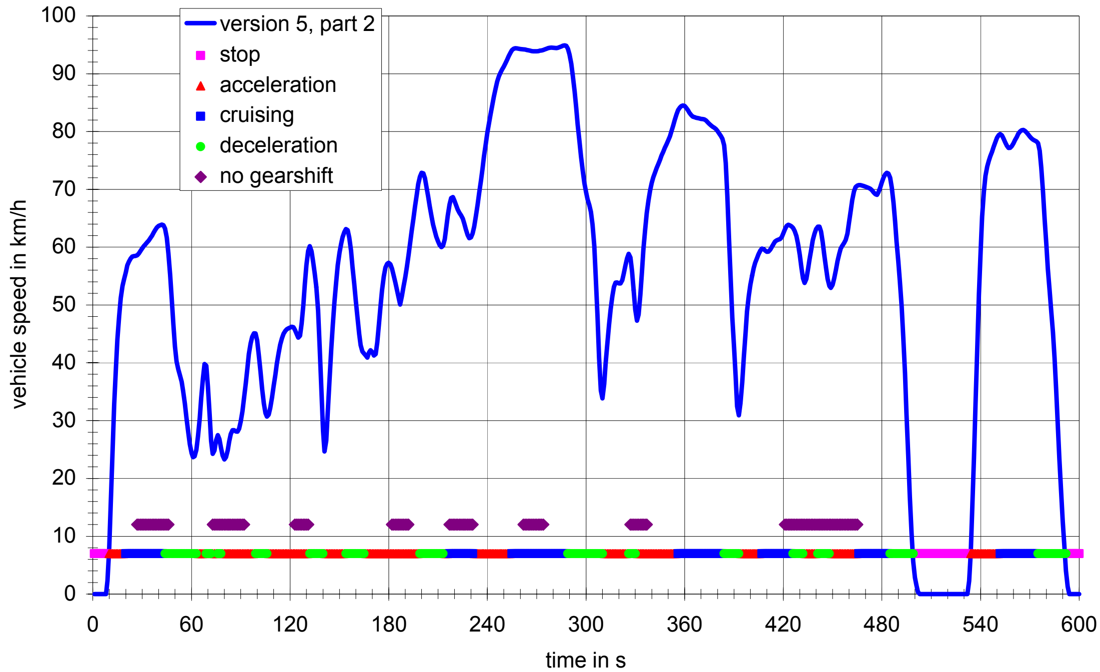

Table 46: Cycle version 5, part 2

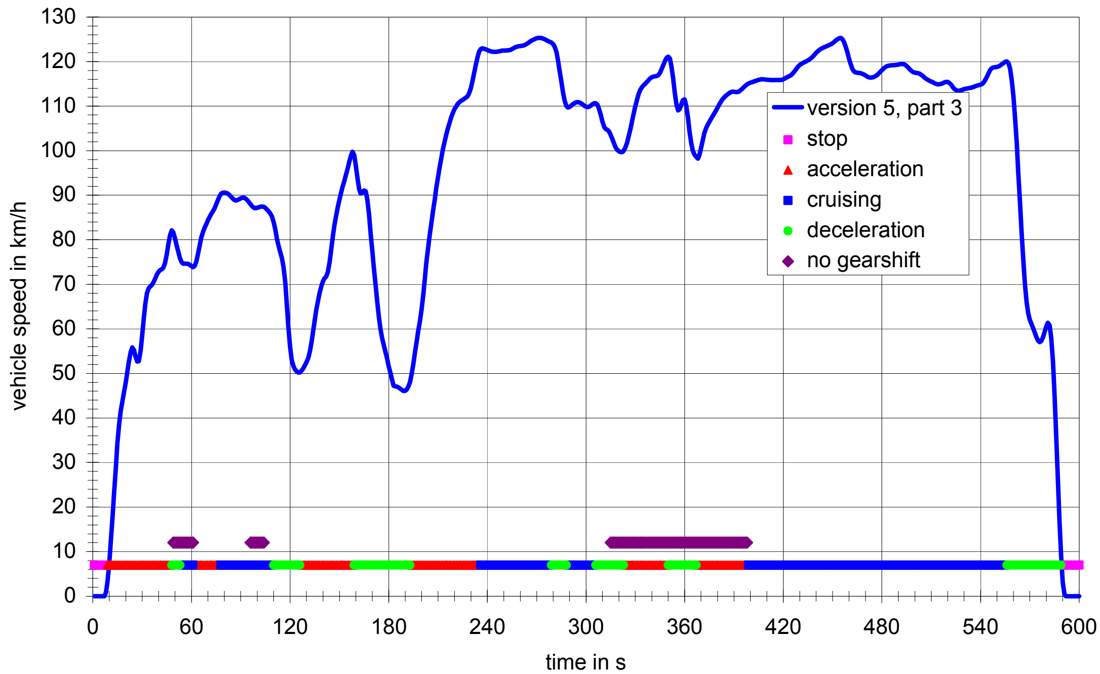

Table 47: Cycle version 5, part 3

Since vehicle speed pattern and gearshift procedure are closely linked, the elimination of malfunctions in the gearshift procedure resulted in cycle version 6.

As an outcome of the driveability validation tests the following modifications led to version 7 which is now the basis for the emissions validation:

In part 1 the modules 2 and 3 were exchanged to get a more realistic pattern for the cold start phase.

To reduce the risk of wheel lock cycle phases with excessive decelerations were modified so that the following limitations are fulfilled:

- vehicle acceleration <= $-2 m/s^2$
- acceleration * vehicle speed <= $-30 m^2/s^3$

The second criterion (acceleration*vehicle speed) was necessary because there were still some sections in the cycles with acceleration values above $-2 m/s^2$ that caused wheel lock in some cases. The modified cycles (version 7) are shown in Table 48 to Table 50.

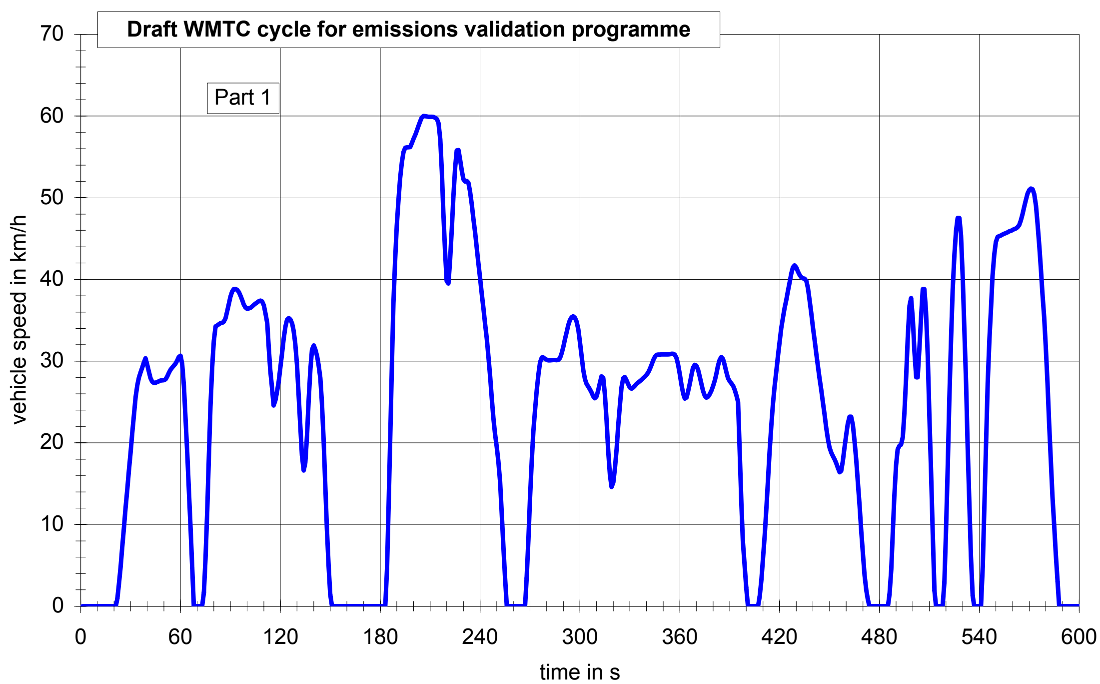

Table 48: Cycle version 7, part 1

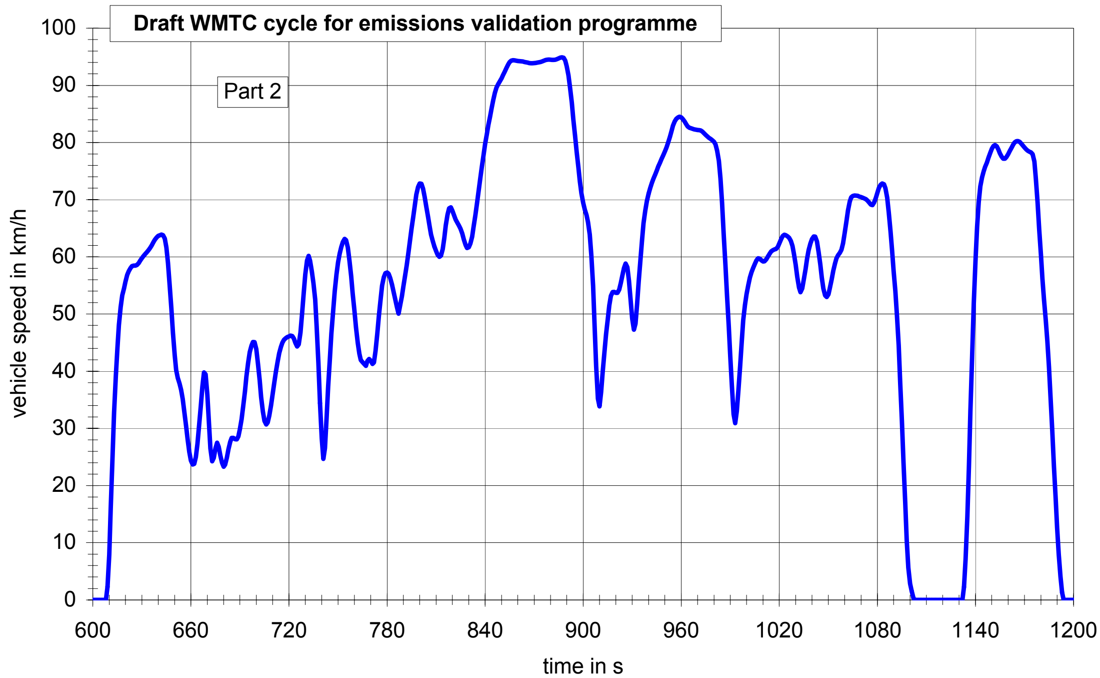

Table 49: Cycle version 7, part 2

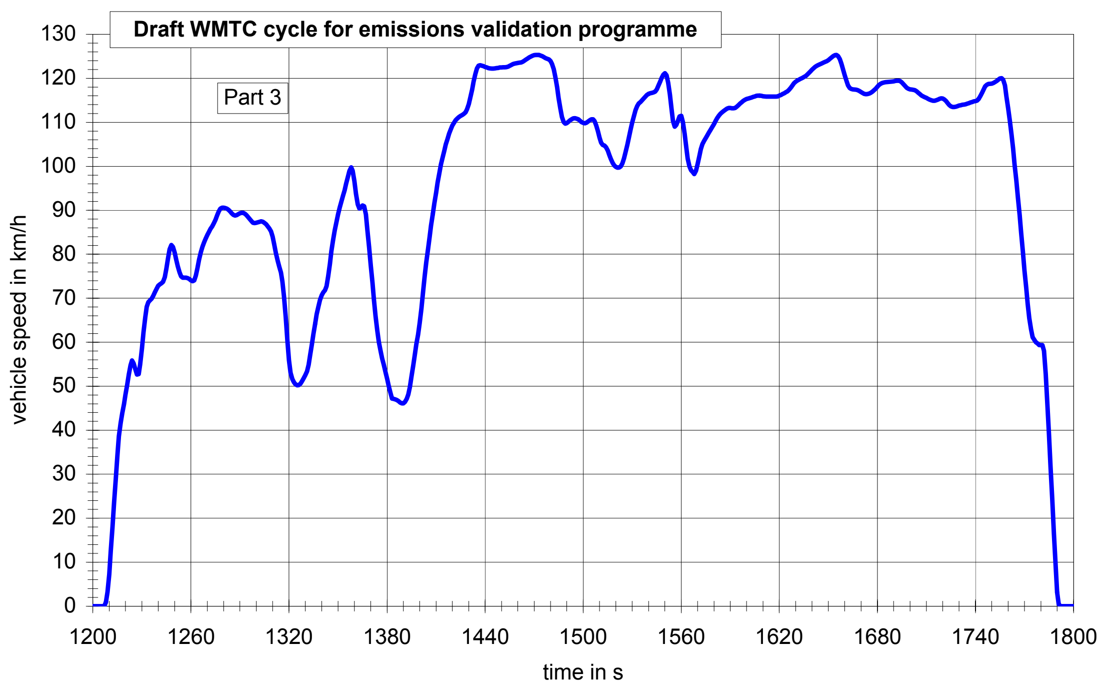

Table 50: Cycle version 7, part 3

Although the results of a detailed analysis of the tyre slip phenomenon showed that the dynamics of the WMTC do not cause higher risks for tyre slip than existing certification cycles it was decided in the WMTC group that this risk should be minimised for the WMTC to improve driveability, independent of the situation for existing cycles.

A renewed analysis showed that the transitions from standstill to ride and vice versa become smooth enough if da/dt is between -0.8 m/s²/s and +0.8 m/s²/s. Consequently the vehicle speed pattern were modified until da/dt falls into that range.

Since it is logical to apply the same criterion also for phases in ride condition where da/dt is outside this range (in cases where a deceleration is immediately followed by an acceleration and vice versa), these cycle phases were modified accordingly.

The results are shown in the following figures.

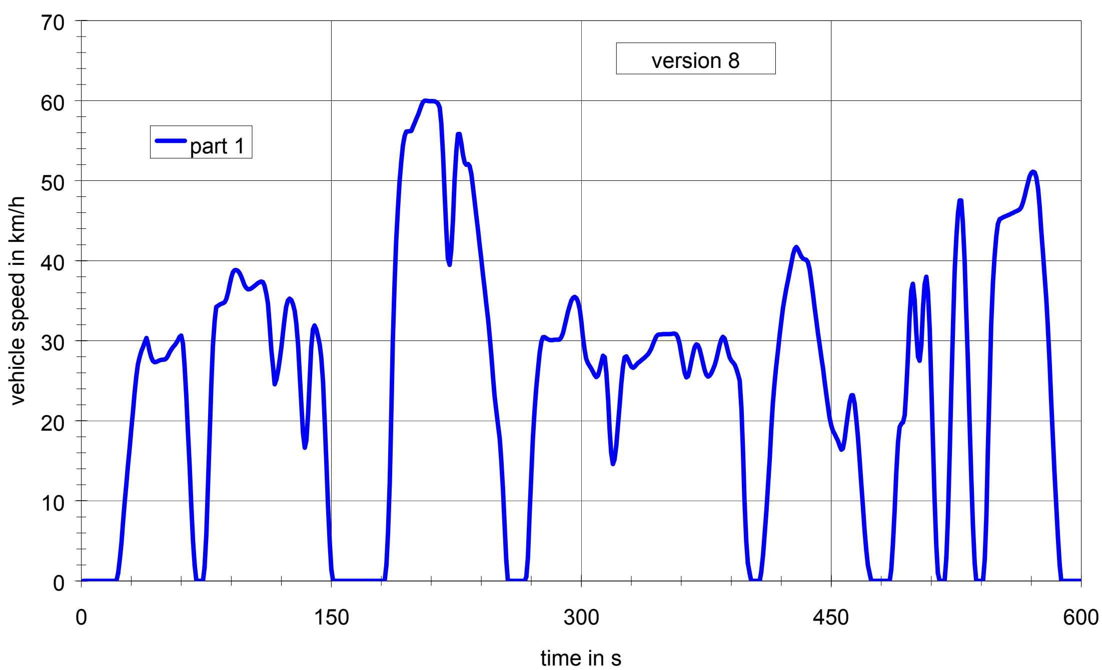

Table 51: Cycle version 8, part 1

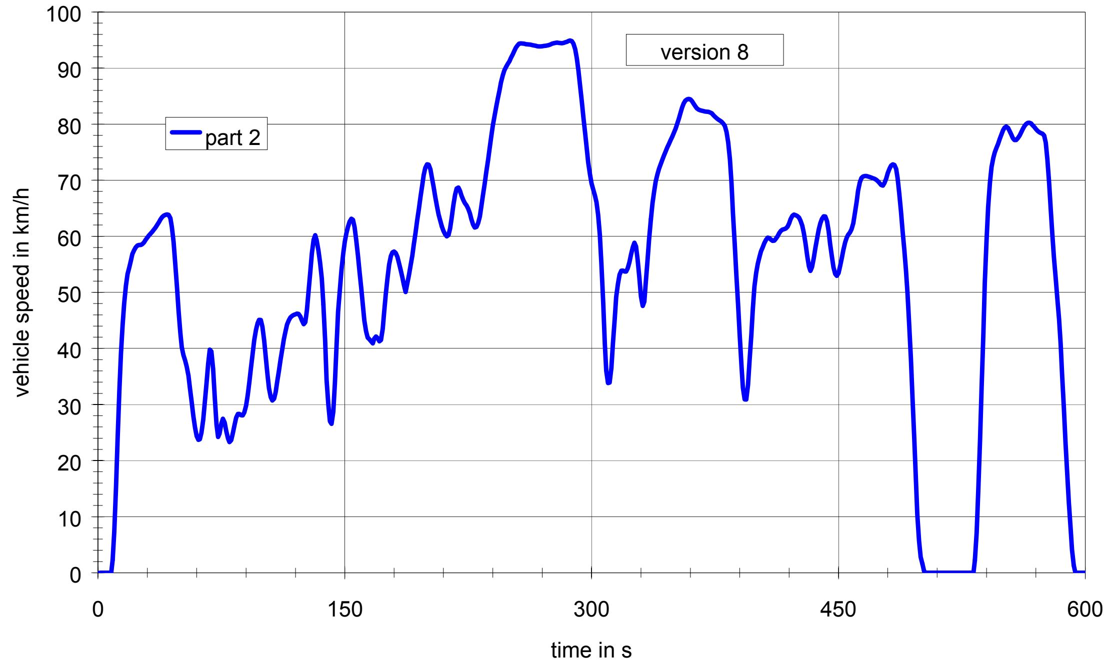

Table 52: Cycle version 8, part 2

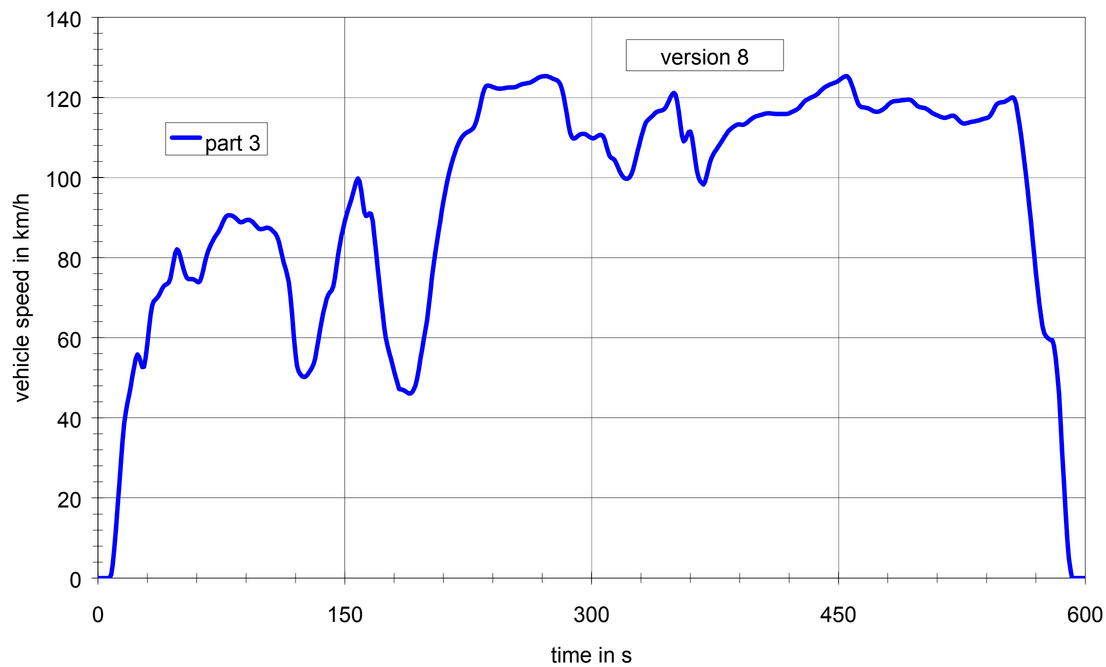

Table 53: Cycle version 8, part 3

During the WMTC FE meeting in Tokyo in April 2002, the Japanese delegation requested a special version of part 1 with a top speed of 50 km/h for low powered motorcycles whose technical specifications are close to mopeds.

Since there are only two modules in part 1 with vehicle speeds above 50 km/h (module 3 and 8), only these modules were modified. Module 3 was replaced by a module taken from in-use measurements of vehicle 6 (this module was closest to the existing one) and module 8 was lowered in speed to fulfil the limitation of 50 km/h.

The result is shown in the following figure.

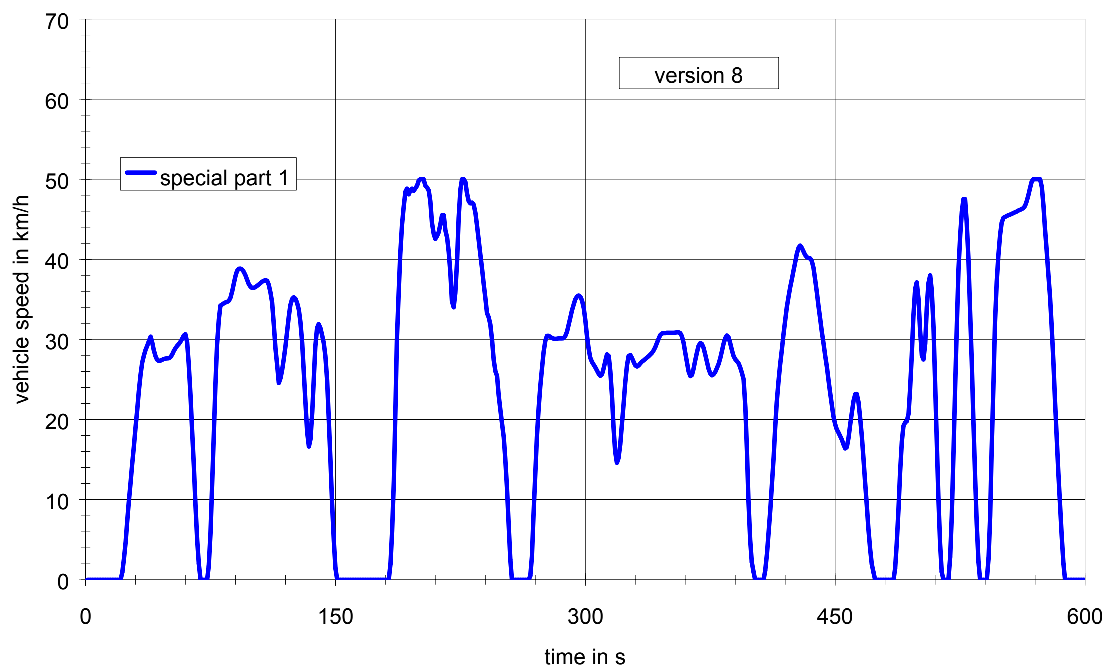

Table 54: Cycle version 8, part 1, reduced speed, with top speed limited to 50 km/h for low powered motorcycles with 50 cm³ engine capacity whose technical specifications are close to mopeds

The compromise found on vehicle classes made it necessary to create additional cycle versions with reduced speed also for part 2 and part 3. In order to achieve that the dynamics of the cycle parts with reduced speed were only changed slightly compared to the normal versions, the speed pattern was not simply limited by the reduced maximum but the whole module containing the maximum speed was lowered at its first acceleration phase and its last deceleration phase (e.g. see Table 57). For consistency reasons this approach was then also applied to part 1, so that version 9 of part 1, reduced speed is slightly different from version 8. But there is no difference between the normal cycle parts of version 8 and 9.

The cycles version 9 are shown in the following figures.

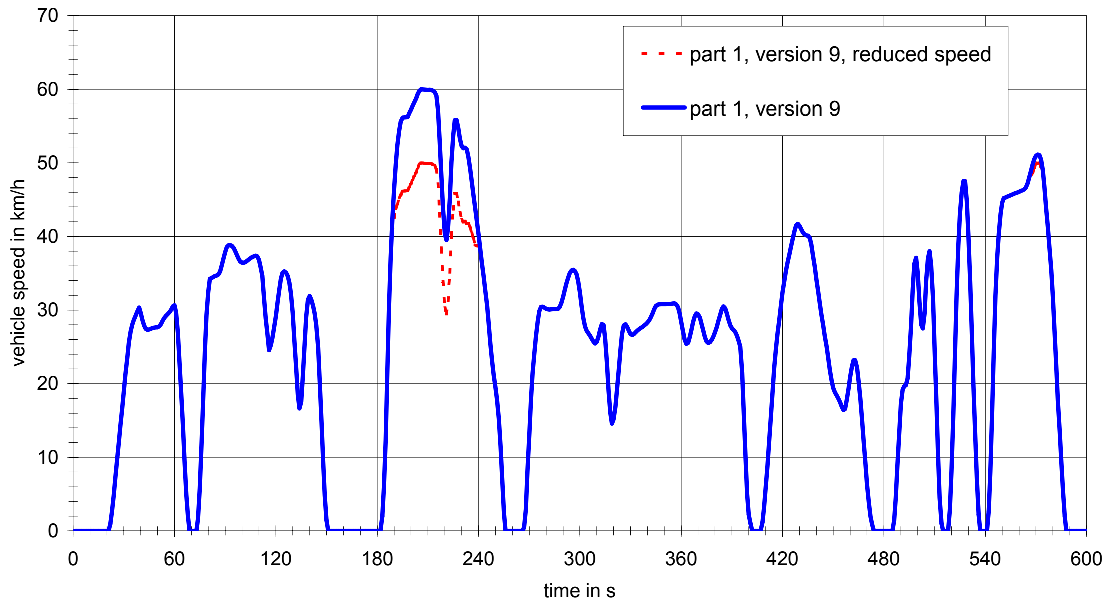

Table 55: Cycle part 1

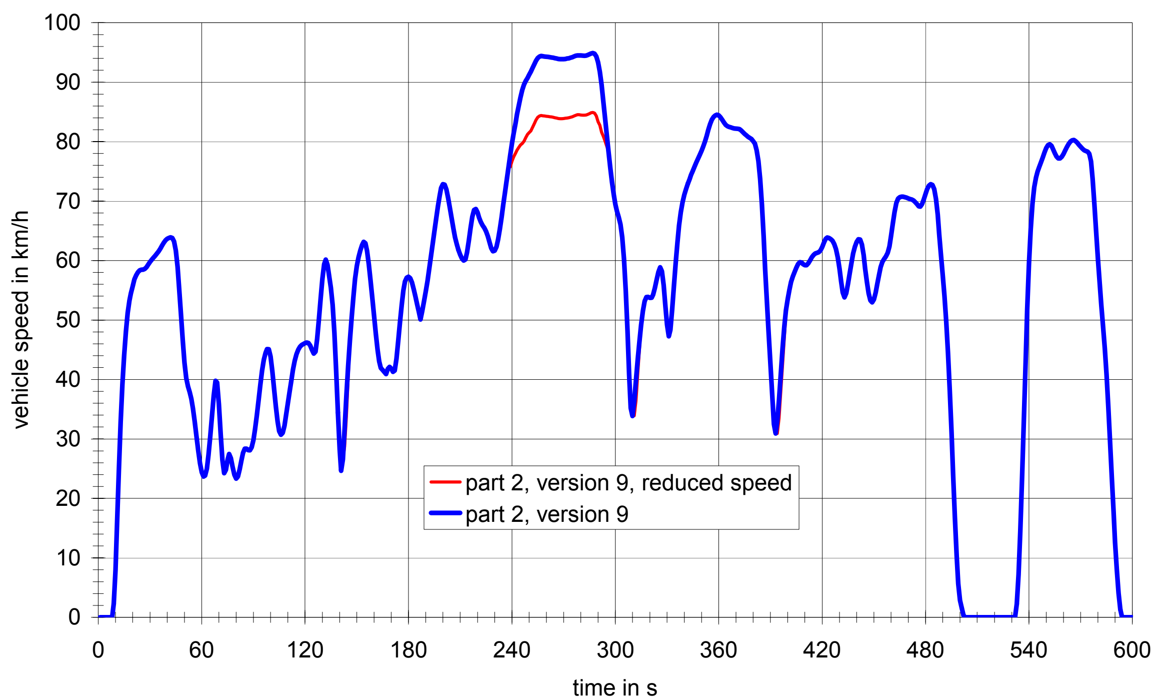

Table 56: Cycle part 2 for vehicle classes 2 and 3

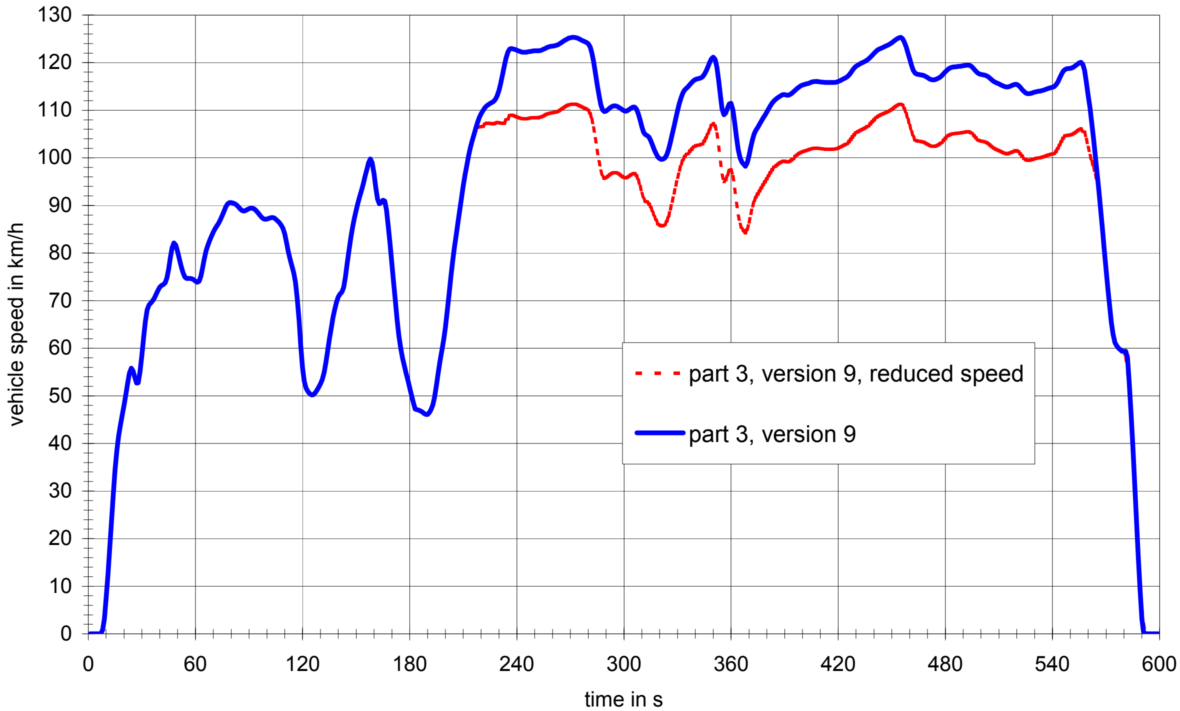

Table 57: Cycle part 3 for vehicle class 3

16. ANNEX B – FINAL CYCLE VERSION

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
1	0.0	0.0	x						61	29.7	29.7				x		
2	0.0	0.0	x						62	26.9	26.9				x		
3	0.0	0.0	x						63	23.0	23.0				x		
4	0.0	0.0	x						64	18.7	18.7				x		
5	0.0	0.0	x						65	14.2	14.2				x		
6	0.0	0.0	x						66	9.4	9.4				x		
7	0.0	0.0	x						67	4.9	4.9				x		
8	0.0	0.0	x						68	2.0	2.0	x					
9	0.0	0.0	x						69	0.0	0.0	x					
10	0.0	0.0	x						70	0.0	0.0	x					
11	0.0	0.0	x						71	0.0	0.0	x					
12	0.0	0.0	x						72	0.0	0.0	x					
13	0.0	0.0	x						73	0.0	0.0	x					
14	0.0	0.0	x						74	1.7	1.7		x				
15	0.0	0.0	x						75	5.8	5.8		x				
16	0.0	0.0	x						76	11.8	11.8		x				
17	0.0	0.0	x						77	18.3	18.3		x				
18	0.0	0.0	x						78	24.5	24.5		x				
19	0.0	0.0	x						79	29.4	29.4		x				
20	0.0	0.0	x						80	32.5	32.5		x				
21	0.0	0.0	x						81	34.2	34.2		x				
22	1.0	1.0		x					82	34.4	34.4		x				
23	2.6	2.6		x					83	34.5	34.5		x				
24	4.8	4.8		x					84	34.6	34.6		x				
25	7.2	7.2		x					85	34.7	34.7		x				
26	9.6	9.6		x					86	34.8	34.8		x				
27	12.0	12.0		x					87	35.2	35.2		x				
28	14.3	14.3		x					88	36.0	36.0		x				
29	16.6	16.6		x					89	37.0	37.0		x				
30	18.9	18.9		x					90	37.9	37.9		x				
31	21.2	21.2		x					91	38.5	38.5		x				
32	23.5	23.5		x					92	38.8	38.8		x				
33	25.6	25.6		x					93	38.8	38.8		x				
34	27.1	27.1		x					94	38.7	38.7		x				
35	28.0	28.0		x					95	38.4	38.4		x				
36	28.7	28.7		x					96	38.0	38.0			x			
37	29.2	29.2		x					97	37.4	37.4			x			
38	29.8	29.8				x			98	36.9	36.9			x			
39	30.3	30.3				x		x	99	36.6	36.6			x			
40	29.6	29.6				x		x	100	36.4	36.4			x			
41	28.7	28.7				x		x	101	36.4	36.4			x			
42	27.9	27.9				x	x	x	102	36.5	36.5			x			
43	27.5	27.5			x		x	x	103	36.7	36.7			x			
44	27.3	27.3			x		x	x	104	36.9	36.9			x			
45	27.3	27.3			x		x	x	105	37.0	37.0			x			
46	27.4	27.4			x		x	x	106	37.2	37.2			x			
47	27.5	27.5			x		x	x	107	37.3	37.3			x			
48	27.6	27.6			x		x	x	108	37.4	37.4			x			
49	27.6	27.6			x		x	x	109	37.3	37.3			x			
50	27.7	27.7			x		x	x	110	36.8	36.8			x			
51	27.8	27.8		x				x	111	35.8	35.8				x		
52	28.1	28.1		x				x	112	34.6	34.6				x		
53	28.6	28.6		x				x	113	31.8	31.8				x		
54	28.9	28.9		x				x	114	28.9	28.9				x		
55	29.2	29.2		x				x	115	26.7	26.7		x				x
56	29.4	29.4		x				x	116	24.6	24.6		x				x
57	29.7	29.7		x				x	117	25.2	25.2		x				x
58	30.1	30.1		x				x	118	26.2	26.2		x				x
59	30.5	30.5		x				x	119	27.5	27.5		x				x
60	30.7	30.7		x				x	120	29.2	29.2		x				x

Table 58: Cycle part 1, version 9, 1 to 120 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
121	31.0	31.0		x				x	181	0.0	0.0	x					
122	32.8	32.8		x				x	182	0.0	0.0	x					
123	34.3	34.3		x				x	183	2.0	2.0	x					
124	35.1	35.1		x					184	6.0	6.0		x				
125	35.3	35.3		x					185	12.4	12.4		x				
126	35.1	35.1		x					186	21.4	21.4		x				
127	34.6	34.6		x					187	30.0	30.0		x				
128	33.7	33.7				x			188	37.1	37.1		x				
129	32.2	32.2				x			189	42.5	40.5		x				
130	29.6	29.6				x			190	46.6	42.6		x				
131	26.0	26.0				x			191	49.8	43.8		x				
132	22.0	22.0				x			192	52.4	44.4		x				
133	18.5	18.5		x					193	54.4	45.4		x				
134	16.6	16.6		x					194	55.6	45.6		x				
135	17.5	17.5		x					195	56.1	46.1		x				
136	20.9	20.9		x					196	56.2	46.2		x				
137	25.2	25.2		x					197	56.2	46.2			x			
138	29.1	29.1		x					198	56.2	46.2			x			
139	31.4	31.4		x					199	56.7	46.7			x			
140	31.9	31.9		x					200	57.2	47.2			x			
141	31.4	31.4				x			201	57.7	47.7			x			
142	30.6	30.6				x			202	58.2	48.2			x			
143	29.5	29.5				x			203	58.7	48.7			x			
144	27.9	27.9				x			204	59.3	49.3			x			
145	24.9	24.9				x			205	59.8	49.8			x			
146	20.2	20.2				x			206	60.0	50.0			x			
147	14.8	14.8				x			207	60.0	50.0			x			
148	9.5	9.5				x			208	59.9	49.9			x			
149	4.8	4.8				x			209	59.9	49.9			x			
150	1.4	1.4				x			210	59.9	49.9			x			
151	0.0	0.0	x						211	59.9	49.9			x			
152	0.0	0.0	x						212	59.9	49.9			x			
153	0.0	0.0	x						213	59.8	49.8			x			
154	0.0	0.0	x						214	59.6	49.6			x			
155	0.0	0.0	x						215	59.1	49.1			x			
156	0.0	0.0	x						216	57.1	47.1				x		
157	0.0	0.0	x						217	53.2	43.2				x		
158	0.0	0.0	x						218	48.3	38.3				x		
159	0.0	0.0	x						219	43.9	33.9				x		
160	0.0	0.0	x						220	40.3	30.3				x		
161	0.0	0.0	x						221	39.5	29.5			x			
162	0.0	0.0	x						222	41.3	31.3			x			
163	0.0	0.0	x						223	45.2	35.2		x				
164	0.0	0.0	x						224	50.1	40.1		x				
165	0.0	0.0	x						225	53.7	43.7		x				
166	0.0	0.0	x						226	55.8	45.8		x				
167	0.0	0.0	x						227	55.8	45.8		x				
168	0.0	0.0	x						228	54.7	44.7				x		
169	0.0	0.0	x						229	53.3	43.3				x		
170	0.0	0.0	x						230	52.2	42.2				x		
171	0.0	0.0	x						231	52.0	42.0				x		
172	0.0	0.0	x						232	52.1	42.1				x		
173	0.0	0.0	x						233	51.8	41.8				x		
174	0.0	0.0	x						234	50.8	41.8				x		
175	0.0	0.0	x						235	49.2	41.2				x		
176	0.0	0.0	x						236	47.4	40.4				x		
177	0.0	0.0	x						237	45.7	39.7				x		
178	0.0	0.0	x						238	43.9	38.9				x		
179	0.0	0.0	x						239	42.0	38.7				x		
180	0.0	0.0	x						240	40.2	38.7				x		

Table 59: Cycle part 1, version 9, 121 to 240 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
241	38.3	38.3				x			301	30.6	30.6			x		x	
242	36.4	36.4				x			302	28.9	28.9			x			
243	34.6	34.6				x			303	27.8	27.8			x			
244	32.7	32.7				x			304	27.2	27.2			x			
245	30.6	30.6				x			305	26.9	26.9			x			
246	28.1	28.1				x			306	26.5	26.5			x			
247	25.4	25.4				x			307	26.1	26.1			x			
248	23.1	23.1				x			308	25.7	25.7			x			
249	21.2	21.2				x			309	25.5	25.5			x			
250	19.5	19.5				x			310	25.7	25.7			x			
251	17.8	17.8				x			311	26.4	26.4			x			
252	15.2	15.2				x			312	27.3	27.3			x			
253	11.5	11.5				x			313	28.1	28.1			x			
254	7.2	7.2				x			314	27.9	27.9				x		
255	2.5	2.5				x			315	26.0	26.0				x		
256	0.0	0.0	x						316	22.7	22.7				x		
257	0.0	0.0	x						317	19.0	19.0				x		
258	0.0	0.0	x						318	16.0	16.0		x				
259	0.0	0.0	x						319	14.6	14.6		x				
260	0.0	0.0	x						320	15.2	15.2		x				
261	0.0	0.0	x						321	16.9	16.9		x				
262	0.0	0.0	x						322	19.3	19.3		x				
263	0.0	0.0	x						323	22.0	22.0		x				
264	0.0	0.0	x						324	24.6	24.6		x				
265	0.0	0.0	x						325	26.8	26.8		x				
266	0.0	0.0	x						326	27.9	27.9		x				
267	0.5	0.5	x						327	28.1	28.1		x				
268	2.9	2.9		x					328	27.7	27.7			x			
269	8.2	8.2		x					329	27.2	27.2			x			
270	13.2	13.2		x					330	26.7	26.7			x			
271	17.8	17.8		x					331	26.6	26.6			x			
272	21.4	21.4		x					332	26.8	26.8			x			
273	24.1	24.1		x					333	27.0	27.0			x			
274	26.4	26.4		x					334	27.2	27.2			x			
275	28.4	28.4		x					335	27.4	27.4			x			
276	29.9	29.9		x					336	27.5	27.5			x			
277	30.4	30.4		x					337	27.7	27.7			x			
278	30.5	30.5			x				338	27.9	27.9			x			
279	30.3	30.3			x				339	28.1	28.1			x			
280	30.2	30.2			x				340	28.3	28.3			x			
281	30.1	30.1			x				341	28.6	28.6			x			
282	30.1	30.1			x				342	29.0	29.0			x			
283	30.1	30.1			x				343	29.5	29.5			x			
284	30.1	30.1			x				344	30.1	30.1			x			
285	30.1	30.1			x				345	30.5	30.5			x			
286	30.1	30.1			x				346	30.7	30.7			x			
287	30.2	30.2			x				347	30.8	30.8			x			
288	30.4	30.4			x		x		348	30.8	30.8			x			
289	31.0	31.0			x		x		349	30.8	30.8			x			
290	31.8	31.8			x		x		350	30.8	30.8			x			
291	32.7	32.7			x		x		351	30.8	30.8			x			
292	33.6	33.6			x		x		352	30.8	30.8			x			
293	34.4	34.4			x		x		353	30.8	30.8			x			
294	35.0	35.0			x		x		354	30.9	30.9			x			
295	35.4	35.4			x		x		355	30.9	30.9			x		x	x
296	35.5	35.5			x		x		356	30.9	30.9			x		x	x
297	35.3	35.3			x		x		357	30.8	30.8			x		x	x
298	34.9	34.9			x		x		358	30.4	30.4			x		x	x
299	33.9	33.9			x		x		359	29.6	29.6			x			x
300	32.4	32.4			x		x		360	28.4	28.4			x			x

Table 60: Cycle part 1, version 9, 241 to 360 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
361	27.1	27.1			x			x	421	34.0	34.0		x				
362	26.0	26.0			x			x	422	35.4	35.4		x				
363	25.4	25.4			x			x	423	36.5	36.5		x				
364	25.5	25.5			x		x	x	424	37.5	37.5		x				
365	26.3	26.3			x		x	x	425	38.6	38.6		x				
366	27.3	27.3			x		x	x	426	39.7	39.7		x				
367	28.4	28.4			x		x	x	427	40.7	40.7		x				
368	29.2	29.2			x		x	x	428	41.5	41.5		x				
369	29.5	29.5			x		x	x	429	41.7	41.7		x				
370	29.4	29.4			x		x	x	430	41.5	41.5				x		
371	28.9	28.9			x		x	x	431	41.0	41.0				x		
372	28.1	28.1			x		x	x	432	40.6	40.6				x		
373	27.2	27.2			x		x	x	433	40.3	40.3				x		
374	26.3	26.3			x		x	x	434	40.1	40.1				x		
375	25.7	25.7			x		x	x	435	40.1	40.1				x		
376	25.5	25.5			x		x	x	436	39.8	39.8				x		
377	25.6	25.6			x		x	x	437	38.9	38.9				x		
378	26.0	26.0			x		x	x	438	37.5	37.5				x		
379	26.4	26.4			x		x	x	439	35.8	35.8				x		
380	27.0	27.0			x		x	x	440	34.2	34.2				x		
381	27.7	27.7			x		x	x	441	32.5	32.5				x		
382	28.5	28.5			x		x	x	442	30.9	30.9				x		
383	29.4	29.4			x		x	x	443	29.4	29.4				x		
384	30.2	30.2			x		x	x	444	28.0	28.0				x		
385	30.5	30.5			x		x	x	445	26.5	26.5				x		
386	30.3	30.3			x		x		446	25.0	25.0				x		
387	29.5	29.5			x		x		447	23.4	23.4				x		
388	28.7	28.7			x		x		448	21.9	21.9				x		
389	27.9	27.9			x		x		449	20.4	20.4				x		
390	27.5	27.5			x				450	19.4	19.4				x		
391	27.3	27.3			x				451	18.8	18.8				x		
392	27.0	27.0			x				452	18.4	18.4				x		
393	26.5	26.5			x				453	18.0	18.0				x		
394	25.8	25.8			x				454	17.5	17.5				x		
395	25.0	25.0				x			455	16.9	16.9		x				
396	21.5	21.5				x			456	16.4	16.4		x				
397	16.0	16.0				x			457	16.6	16.6		x				
398	10.0	10.0				x			458	17.7	17.7		x				
399	5.0	5.0				x			459	19.3	19.3		x				
400	2.2	2.2				x			460	20.9	20.9		x				
401	1.0	1.0	x						461	22.3	22.3		x				
402	0.0	0.0	x						462	23.2	23.2				x		
403	0.0	0.0	x						463	23.2	23.2				x		
404	0.0	0.0	x						464	22.2	22.2				x		
405	0.0	0.0	x						465	20.3	20.3				x		
406	0.0	0.0	x						466	17.9	17.9				x		
407	0.0	0.0	x						467	15.2	15.2				x		
408	1.2	1.2		x					468	12.3	12.3				x		
409	3.2	3.2		x					469	9.3	9.3				x		
410	5.9	5.9		x					470	6.4	6.4				x		
411	8.8	8.8		x					471	3.8	3.8				x		
412	12.0	12.0		x					472	1.9	1.9				x		
413	15.4	15.4		x					473	0.9	0.9				x		
414	18.9	18.9		x					474	0.0	0.0	x					
415	22.1	22.1		x					475	0.0	0.0	x					
416	24.7	24.7		x					476	0.0	0.0	x					
417	26.8	26.8		x					477	0.0	0.0	x					
418	28.7	28.7		x					478	0.0	0.0	x					
419	30.6	30.6		x					479	0.0	0.0	x					
420	32.4	32.4		x					480	0.0	0.0	x					

Table 61: Cycle part 1, version 9, 361 to 480 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
481	0.0	0.0	x						541	0.0	0.0	x					
482	0.0	0.0	x						542	2.7	2.7		x				
483	0.0	0.0	x						543	8.0	8.0		x				
484	0.0	0.0	x						544	16.0	16.0		x				
485	0.0	0.0	x						545	24.0	24.0		x				
486	1.4	1.4		x					546	32.0	32.0		x				
487	4.5	4.5		x					547	37.2	37.2		x				
488	8.8	8.8		x					548	40.4	40.4		x				
489	13.4	13.4		x					549	43.0	43.0		x				
490	17.3	17.3		x					550	44.6	44.6		x				
491	19.2	19.2		x					551	45.2	45.2			x			
492	19.7	19.7		x					552	45.3	45.3			x			
493	19.8	19.8		x					553	45.4	45.4			x			
494	20.7	20.7		x					554	45.5	45.5			x			
495	23.6	23.6		x					555	45.6	45.6			x			
496	28.1	28.1		x					556	45.7	45.7			x			
497	32.8	32.8		x					557	45.8	45.8			x			
498	36.3	36.3		x					558	45.9	45.9			x			
499	37.1	37.1				x			559	46.0	46.0			x			
500	35.1	35.1				x		x	560	46.1	46.1			x			
501	31.1	31.1				x		x	561	46.2	46.2			x			
502	28.0	28.0				x		x	562	46.3	46.3			x			
503	27.5	27.5		x				x	563	46.4	46.4			x			
504	29.5	29.5		x				x	564	46.7	46.7			x			
505	34.0	34.0		x				x	565	47.2	47.2			x			
506	37.0	37.0		x				x	566	48.0	48.0			x			
507	38.0	38.0				x		x	567	48.9	48.4			x			
508	36.1	36.1				x			568	49.8	48.6			x			
509	31.5	31.5				x			569	50.5	49.4			x			
510	24.5	24.5				x			570	51.0	49.8			x			
511	17.5	17.5				x			571	51.1	50.0			x			
512	10.5	10.5				x			572	51.0	49.9				x		
513	4.5	4.5				x			573	50.4	49.3				x		
514	1.0	1.0	x						574	49.0	49.0				x		
515	0.0	0.0	x						575	46.7	46.7				x		
516	0.0	0.0	x						576	44.0	44.0				x		
517	0.0	0.0	x						577	41.1	41.1				x		
518	0.0	0.0	x						578	38.3	38.3				x		
519	2.9	2.9		x					579	35.4	35.4				x		
520	8.0	8.0		x					580	31.8	31.8				x		
521	16.0	16.0		x					581	27.3	27.3				x		
522	24.0	24.0		x					582	22.4	22.4				x		
523	32.0	32.0		x					583	17.7	17.7				x		
524	38.8	38.8		x					584	13.4	13.4				x		
525	43.1	43.1		x					585	9.3	9.3				x		
526	46.0	46.0		x					586	5.5	5.5				x		
527	47.5	47.5		x					587	2.0	2.0				x		
528	47.5	47.5				x			588	0.0	0.0	x					
529	44.8	44.8				x			589	0.0	0.0	x					
530	40.1	40.1				x			590	0.0	0.0	x					
531	33.8	33.8				x			591	0.0	0.0	x					
532	27.2	27.2				x			592	0.0	0.0	x					
533	20.0	20.0				x			593	0.0	0.0	x					
534	12.8	12.8				x			594	0.0	0.0	x					
535	7.0	7.0				x			595	0.0	0.0	x					
536	2.2	2.2				x			596	0.0	0.0	x					
537	0.0	0.0	x						597	0.0	0.0	x					
538	0.0	0.0	x						598	0.0	0.0	x					
539	0.0	0.0	x						599	0.0	0.0	x					
540	0.0	0.0	x						600	0.0	0.0	x					

Table 62: Cycle part 1, version 9, 481 to 600 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
1	0.0	0.0	x						61	23.7	23.7		x				x
2	0.0	0.0	x						62	23.8	23.8		x				x
3	0.0	0.0	x						63	25.0	25.0		x				x
4	0.0	0.0	x						64	27.3	27.3		x				x
5	0.0	0.0	x						65	30.4	30.4		x				x
6	0.0	0.0	x						66	33.9	33.9		x				x
7	0.0	0.0	x						67	37.3	37.3		x				x
8	0.0	0.0	x						68	39.8	39.8		x				x
9	2.3	2.3	x						69	39.5	39.5				x		
10	7.3	7.3		x					70	36.3	36.3				x		
11	15.2	15.2		x					71	31.4	31.4				x		
12	23.9	23.9		x					72	26.5	26.5				x		
13	32.5	32.5		x					73	24.2	24.2		x				x
14	39.2	39.2		x					74	24.8	24.8		x				x
15	44.1	44.1		x					75	26.6	26.6		x				x
16	48.1	48.1		x					76	27.5	27.5				x		x
17	51.2	51.2		x					77	26.8	26.8				x		x
18	53.3	53.3		x					78	25.3	25.3				x		x
19	54.5	54.5		x					79	24.0	24.0		x				x
20	55.7	55.7			x				80	23.3	23.3		x				x
21	56.8	56.8			x				81	23.7	23.7		x				x
22	57.5	57.5			x				82	24.9	24.9		x				x
23	58.0	58.0			x				83	26.4	26.4		x				x
24	58.4	58.4			x				84	27.7	27.7		x				x
25	58.5	58.5			x				85	28.3	28.3		x				x
26	58.5	58.5			x				86	28.3	28.3		x				x
27	58.6	58.6			x		x		87	28.1	28.1		x				x
28	58.9	58.9			x		x		88	28.1	28.1		x				x
29	59.3	59.3			x		x		89	28.6	28.6		x				x
30	59.8	59.8			x		x		90	29.8	29.8		x				x
31	60.2	60.2			x		x		91	31.6	31.6		x				x
32	60.5	60.5			x		x		92	33.9	33.9		x				x
33	60.8	60.8			x		x		93	36.5	36.5		x				
34	61.1	61.1			x		x		94	39.1	39.1		x				
35	61.5	61.5			x		x		95	41.5	41.5		x				
36	62.0	62.0			x		x		96	43.3	43.3		x				
37	62.5	62.5			x		x		97	44.5	44.5		x				
38	63.0	63.0			x		x		98	45.1	45.1		x				
39	63.4	63.4			x		x		99	45.1	45.1				x		
40	63.7	63.7			x		x		100	43.9	43.9				x		
41	63.8	63.8			x		x		101	41.4	41.4				x		
42	63.9	63.9			x		x		102	38.4	38.4				x		
43	63.8	63.8			x		x		103	35.5	35.5				x		
44	63.2	63.2				x	x		104	32.9	32.9				x		
45	61.7	61.7				x	x		105	31.3	31.3				x		
46	58.9	58.9				x	x		106	30.7	30.7		x				x
47	55.2	55.2				x			107	31.0	31.0		x				x
48	51.0	51.0				x			108	32.2	32.2		x				x
49	46.7	46.7				x			109	34.0	34.0		x				x
50	42.8	42.8				x			110	36.0	36.0		x				
51	40.2	40.2				x			111	37.9	37.9		x				
52	38.8	38.8				x			112	39.8	39.8		x				
53	37.9	37.9				x			113	41.6	41.6		x				
54	36.7	36.7				x			114	43.1	43.1		x				
55	35.1	35.1				x			115	44.3	44.3		x				
56	32.9	32.9				x			116	45.0	45.0		x				
57	30.4	30.4				x			117	45.5	45.5		x				
58	28.0	28.0				x			118	45.8	45.8		x			x	
59	25.9	25.9				x			119	46.0	46.0		x			x	
60	24.4	24.4		x				x	120	46.1	46.1		x			x	

<u>Table</u> 63: Cycle part 2, version 9 for vehicle classes 2 and 3, 1 to 120 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
121	46.2	46.2		x			x		181	57.0	57.0				x		
122	46.1	46.1		x			x		182	56.3	56.3				x		
123	45.7	45.7		x			x		183	55.2	55.2				x		
124	45.0	45.0		x					184	53.9	53.9				x		
125	44.3	44.3		x					185	52.6	52.6				x		
126	44.7	44.7		x					186	51.3	51.3		x				
127	46.8	46.8		x					187	50.1	50.1		x				
128	50.1	50.1		x					188	51.5	51.5		x				
129	53.6	53.6		x					189	53.1	53.1		x				
130	56.9	56.9		x					190	54.8	54.8		x				
131	59.4	59.4		x					191	56.6	56.6		x				
132	60.2	60.2				x			192	58.5	58.5		x				
133	59.3	59.3				x			193	60.6	60.6		x				
134	57.5	57.5				x			194	62.8	62.8		x				
135	55.4	55.4				x			195	64.9	64.9		x				
136	52.5	52.5				x			196	67.0	67.0		x				
137	47.9	47.9				x			197	69.1	69.1		x				
138	41.4	41.4				x			198	70.9	70.9		x				
139	34.4	34.4				x			199	72.2	72.2		x				
140	30.0	30.0		x				x	200	72.8	72.8				x		
141	27.0	27.0		x				x	201	72.8	72.8				x		
142	26.5	26.5		x				x	202	71.9	71.9				x		
143	28.7	28.7		x				x	203	70.5	70.5				x		
144	33.8	33.8		x					204	68.8	68.8				x		
145	40.3	40.3		x					205	67.1	67.1				x		
146	46.6	46.6		x					206	65.4	65.4				x		
147	50.4	50.4		x					207	63.9	63.9				x		
148	53.9	53.9		x					208	62.7	62.7				x		
149	56.9	56.9		x					209	61.8	61.8				x		
150	59.1	59.1		x					210	61.0	61.0				x		
151	60.6	60.6		x					211	60.4	60.4				x	x	
152	61.7	61.7		x					212	60.0	60.0				x	x	
153	62.6	62.6		x					213	60.2	60.2		x			x	
154	63.1	63.1				x			214	61.4	61.4		x			x	
155	62.9	62.9				x			215	63.3	63.3		x			x	
156	61.6	61.6				x			216	65.5	65.5		x			x	
157	59.4	59.4				x			217	67.4	67.4		x			x	
158	56.6	56.6				x			218	68.5	68.5		x			x	
159	53.7	53.7				x			219	68.7	68.7				x	x	
160	50.7	50.7				x			220	68.1	68.1				x	x	
161	47.7	47.7				x			221	67.2	67.2				x	x	
162	45.0	45.0				x			222	66.5	66.5				x	x	
163	43.0	43.0				x			223	65.9	65.9				x	x	
164	41.9	41.9				x			224	65.5	65.5				x	x	
165	41.6	41.6				x			225	64.9	64.9				x	x	
166	41.3	41.3		x					226	64.1	64.1				x	x	
167	40.9	40.9		x					227	63.0	63.0				x	x	
168	41.8	41.8		x					228	62.1	62.1				x	x	
169	42.1	42.1		x					229	61.6	61.6		x			x	
170	41.8	41.8		x					230	61.7	61.7		x			x	
171	41.3	41.3		x					231	62.3	62.3		x			x	
172	41.5	41.5		x					232	63.5	63.5		x			x	
173	43.5	43.5		x					233	65.3	65.3		x			x	
174	46.5	46.5		x					234	67.3	67.3		x			x	
175	49.7	49.7		x					235	69.3	69.3		x			x	
176	52.6	52.6		x					236	71.4	71.4		x			x	
177	55.0	55.0		x					237	73.5	73.5		x				
178	56.5	56.5		x					238	75.6	75.6		x				
179	57.1	57.1		x					239	77.7	75.7		x				
180	57.3	57.3				x			240	79.7	76.7		x				

Table 64: Cycle part 2, version 9 for vehicle classes 2 and 3, 121 to 240 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
241	81.5	77.5		x					301	68.3	68.3				x		
242	83.0	78.0		x					302	67.3	67.3				x		
243	84.5	78.5		x					303	66.1	66.1				x		
244	86.0	79.0		x					304	63.9	63.9				x		
245	87.4	79.4		x					305	60.2	60.2				x		
246	88.7	79.7		x					306	54.9	54.9				x		
247	89.6	80.1		x					307	48.1	48.1				x		
248	90.2	80.7		x					308	40.9	40.9				x		
249	90.7	81.2		x					309	36.0	36.0				x		
250	91.2	81.5		x					310	33.9	33.9				x		
251	91.8	81.8		x					311	33.9	33.9		x				
252	92.4	82.4		x					312	36.5	36.5		x				
253	93.0	83.0		x					313	41.0	41.0		x				
254	93.6	83.6		x					314	45.3	45.3		x				
255	94.1	84.1			x				315	49.2	49.2		x				
256	94.3	84.3			x				316	51.5	51.5		x				
257	94.4	84.4			x				317	53.2	53.2		x				
258	94.4	84.4			x				318	53.9	53.9		x				
259	94.3	84.3			x				319	53.9	53.9		x				
260	94.3	84.3			x				320	53.7	53.7		x				
261	94.2	84.2			x				321	53.7	53.7		x				
262	94.2	84.2			x		x		322	54.3	54.3		x				
263	94.2	84.2			x		x		323	55.4	55.4		x				
264	94.1	84.1			x		x		324	56.8	56.8		x				
265	94.0	84.0			x		x		325	58.1	58.1		x				
266	94.0	84.0			x		x		326	58.8	58.8				x		
267	93.9	83.9			x		x		327	58.2	58.2				x		
268	93.9	83.9			x		x		328	55.8	55.8				x		
269	93.9	83.9			x		x		329	52.6	52.6				x		
270	93.9	83.9			x		x		330	49.2	49.2				x		
271	93.9	83.9			x		x		331	47.6	47.6		x				
272	94.0	84.0			x		x		332	48.4	48.4		x				
273	94.0	84.0			x		x		333	51.8	51.8		x				
274	94.1	84.1			x		x		334	55.7	55.7		x				
275	94.2	84.2			x				335	59.6	59.6		x				
276	94.3	84.3			x				336	63.0	63.0		x				
277	94.4	84.4			x				337	65.9	65.9		x				
278	94.5	84.5			x				338	68.1	68.1		x				
279	94.5	84.5			x				339	69.8	69.8		x				
280	94.5	84.5			x				340	71.1	71.1		x				
281	94.5	84.5			x				341	72.1	72.1		x				
282	94.4	84.4			x				342	72.9	72.9		x				
283	94.5	84.5			x				343	73.7	73.7		x				
284	94.6	84.6			x				344	74.4	74.4		x				
285	94.7	84.7			x				345	75.1	75.1		x				
286	94.8	84.8			x				346	75.8	75.8		x				
287	94.9	84.9			x				347	76.5	76.5		x				
288	94.8	84.8			x				348	77.2	77.2		x				
289	94.3	84.3				x			349	77.8	77.8		x				
290	93.3	83.3				x			350	78.5	78.5		x				
291	91.7	82.7				x			351	79.2	79.2		x				
292	89.6	81.6				x			352	80.0	80.0		x				
293	87.0	81.0				x			353	81.0	81.0		x				
294	84.1	80.1				x			354	82.0	82.0		x				
295	81.2	79.2				x			355	82.9	82.9		x				
296	78.4	78.4				x			356	83.7	83.7		x				
297	75.7	75.7				x			357	84.2	84.2			x			
298	73.2	73.2				x			358	84.4	84.4			x			
299	71.1	71.1				x			359	84.5	84.5			x			
300	69.5	69.5				x			360	84.4	84.4			x			

Table 65: Cycle part 2, version 9 for vehicle classes 2 and 3, 241 to 360 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
361	84.1	84.1			x				421	63.0	63.0			x		x	
362	83.7	83.7			x				422	63.6	63.6			x		x	
363	83.2	83.2			x				423	63.9	63.9			x		x	
364	82.8	82.8			x				424	63.8	63.8			x		x	
365	82.6	82.6			x				425	63.6	63.6			x		x	
366	82.5	82.5			x				426	63.3	63.3				x	x	
367	82.4	82.4			x				427	62.8	62.8				x	x	
368	82.3	82.3			x				428	61.9	61.9				x	x	
369	82.2	82.2			x				429	60.5	60.5				x	x	
370	82.2	82.2			x				430	58.6	58.6				x	x	
371	82.2	82.2			x				431	56.5	56.5				x	x	
372	82.1	82.1			x				432	54.6	54.6				x	x	
373	81.9	81.9			x				433	53.8	53.8		x			x	
374	81.6	81.6			x				434	54.5	54.5		x			x	
375	81.3	81.3			x				435	56.1	56.1		x			x	
376	81.1	81.1			x				436	57.9	57.9		x			x	
377	80.8	80.8			x				437	59.6	59.6		x			x	
378	80.6	80.6			x				438	61.2	61.2		x			x	
379	80.4	80.4			x				439	62.3	62.3		x			x	
380	80.1	80.1			x				440	63.1	63.1		x			x	
381	79.7	79.7			x				441	63.6	63.6				x	x	
382	78.6	78.6			x				442	63.5	63.5				x	x	
383	76.8	76.8			x				443	62.7	62.7				x	x	
384	73.7	73.7				x			444	60.9	60.9				x	x	
385	69.4	69.4				x			445	58.7	58.7				x	x	
386	64.0	64.0				x			446	56.4	56.4				x	x	
387	58.6	58.6				x			447	54.5	54.5				x	x	
388	53.2	53.2				x			448	53.3	53.3		x			x	
389	47.8	47.8				x			449	53.0	53.0		x			x	
390	42.4	42.4				x			450	53.5	53.5		x			x	
391	37.0	37.0				x			451	54.6	54.6		x			x	
392	33.0	33.0		x					452	56.1	56.1		x			x	
393	30.9	30.9		x					453	57.6	57.6		x			x	
394	30.9	30.9		x					454	58.9	58.9		x			x	
395	33.5	33.5		x					455	59.8	59.8		x			x	
396	38.0	38.0		x					456	60.3	60.3		x			x	
397	42.5	42.5		x					457	60.7	60.7		x			x	
398	47.0	47.0		x					458	61.3	61.3		x			x	
399	51.0	51.0		x					459	62.3	62.3		x			x	
400	53.5	53.5		x					460	64.1	64.1		x			x	
401	55.1	55.1		x					461	66.2	66.2		x			x	
402	56.4	56.4		x					462	68.1	68.1		x			x	
403	57.3	57.3		x					463	69.7	69.7		x			x	
404	58.1	58.1		x					464	70.4	70.4		x			x	
405	58.8	58.8		x					465	70.7	70.7		x			x	
406	59.4	59.4		x					466	70.7	70.7			x			
407	59.8	59.8			x				467	70.7	70.7			x			
408	59.7	59.7			x				468	70.7	70.7			x			
409	59.4	59.4			x				469	70.6	70.6			x			
410	59.2	59.2			x				470	70.5	70.5			x			
411	59.2	59.2			x				471	70.3	70.3			x			
412	59.5	59.5			x				472	70.2	70.2			x			
413	60.0	60.0			x				473	70.1	70.1			x			
414	60.5	60.5			x				474	69.8	69.8			x			
415	61.0	61.0			x				475	69.5	69.5			x			
416	61.2	61.2			x				476	69.1	69.1			x			
417	61.3	61.3			x				477	69.1	69.1			x			
418	61.4	61.4			x				478	69.5	69.5			x			
419	61.7	61.7			x				479	70.3	70.3			x		x	
420	62.3	62.3			x				480	71.2	71.2			x		x	

Table 66: Cycle part 2, version 9 for vehicle classes 2 and 3, 361 to 480 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
481	72.0	72.0			x		x		541	65.3	65.3		x				
482	72.6	72.6			x		x		542	69.6	69.6		x				
483	72.8	72.8			x		x		543	72.3	72.3		x				
484	72.7	72.7			x		x		544	73.9	73.9		x				
485	72.0	72.0				x	x		545	75.0	75.0		x				
486	70.3	70.3				x			546	75.7	75.7		x				
487	67.7	67.7				x			547	76.5	76.5		x				
488	64.4	64.4				x			548	77.3	77.3		x				
489	61.0	61.0				x			549	78.2	78.2		x				
490	57.6	57.6				x			550	78.9	78.9		x				
491	54.0	54.0				x			551	79.4	79.4		x				
492	49.7	49.7				x			552	79.6	79.6			x			
493	44.4	44.4				x			553	79.3	79.3			x			
494	38.2	38.2				x			554	78.8	78.8			x			
495	31.2	31.2				x			555	78.1	78.1			x			
496	24.0	24.0				x			556	77.5	77.5			x			
497	16.8	16.8				x			557	77.2	77.2			x			
498	10.4	10.4				x			558	77.2	77.2			x			
499	5.7	5.7				x			559	77.5	77.5			x			
500	2.8	2.8	x						560	77.9	77.9			x			
501	1.6	1.6	x						561	78.5	78.5			x			
502	0.3	0.3	x						562	79.1	79.1			x			
503	0.0	0.0	x						563	79.6	79.6			x			
504	0.0	0.0	x						564	80.0	80.0			x			
505	0.0	0.0	x						565	80.2	80.2			x			
506	0.0	0.0	x						566	80.3	80.3			x			
507	0.0	0.0	x						567	80.1	80.1			x			
508	0.0	0.0	x						568	79.8	79.8			x			
509	0.0	0.0	x						569	79.5	79.5			x			
510	0.0	0.0	x						570	79.1	79.1			x			
511	0.0	0.0	x						571	78.8	78.8			x			
512	0.0	0.0	x						572	78.6	78.6			x			
513	0.0	0.0	x						573	78.4	78.4			x			
514	0.0	0.0	x						574	78.3	78.3			x			
515	0.0	0.0	x						575	78.0	78.0				x		
516	0.0	0.0	x						576	76.7	76.7				x		
517	0.0	0.0	x						577	73.7	73.7				x		
518	0.0	0.0	x						578	69.5	69.5				x		
519	0.0	0.0	x						579	64.8	64.8				x		
520	0.0	0.0	x						580	60.3	60.3				x		
521	0.0	0.0	x						581	56.2	56.2				x		
522	0.0	0.0	x						582	52.5	52.5				x		
523	0.0	0.0	x						583	49.0	49.0				x		
524	0.0	0.0	x						584	45.2	45.2				x		
525	0.0	0.0	x						585	40.8	40.8				x		
526	0.0	0.0	x						586	35.4	35.4				x		
527	0.0	0.0	x						587	29.4	29.4				x		
528	0.0	0.0	x						588	23.4	23.4				x		
529	0.0	0.0	x						589	17.7	17.7				x		
530	0.0	0.0	x						590	12.6	12.6				x		
531	0.0	0.0	x						591	8.0	8.0				x		
532	0.0	0.0	x						592	4.1	4.1				x		
533	2.3	2.3	x						593	1.3	1.3	x					
534	7.2	7.2		x					594	0.0	0.0	x					
535	14.6	14.6		x					595	0.0	0.0	x					
536	23.5	23.5		x					596	0.0	0.0	x					
537	33.0	33.0		x					597	0.0	0.0	x					
538	42.7	42.7		x					598	0.0	0.0	x					
539	51.8	51.8		x					599	0.0	0.0	x					
540	59.4	59.4		x					600	0.0	0.0	x					

Table 67: Cycle part 2, version 9 for vehicle classes 2 and 3, 481 to 600 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
1	0.0	0.0	x						61	73.9	73.9		x			x	
2	0.0	0.0	x						62	74.1	74.1		x			x	
3	0.0	0.0	x						63	75.1	75.1		x			x	
4	0.0	0.0	x						64	76.8	76.8		x			x	
5	0.0	0.0	x						65	78.7	78.7		x			x	
6	0.0	0.0	x						66	80.4	80.4		x			x	
7	0.0	0.0	x						67	81.7	81.7		x			x	
8	0.9	0.9	x						68	82.6	82.6		x				
9	3.2	3.2		x					69	83.5	83.5		x				
10	7.3	7.3		x					70	84.4	84.4		x				
11	12.4	12.4		x					71	85.1	85.1		x				
12	17.9	17.9		x					72	85.7	85.7		x				
13	23.5	23.5		x					73	86.3	86.3		x				
14	29.1	29.1		x					74	87.0	87.0		x				
15	34.3	34.3		x					75	87.9	87.9		x				
16	38.6	38.6		x					76	88.8	88.8		x				
17	41.6	41.6		x					77	89.7	89.7		x				
18	43.9	43.9		x					78	90.3	90.3			x			
19	45.9	45.9		x					79	90.6	90.6			x			
20	48.1	48.1		x					80	90.6	90.6			x			
21	50.3	50.3		x					81	90.5	90.5			x			
22	52.6	52.6		x					82	90.4	90.4			x			
23	54.8	54.8		x					83	90.1	90.1			x			
24	55.8	55.8		x					84	89.7	89.7			x			
25	55.2	55.2		x					85	89.3	89.3			x			
26	53.8	53.8		x					86	88.9	88.9			x			
27	52.7	52.7		x					87	88.8	88.8			x			
28	52.8	52.8		x					88	88.9	88.9			x			
29	55.0	55.0		x					89	89.1	89.1			x			
30	58.5	58.5		x					90	89.3	89.3			x			
31	62.3	62.3		x					91	89.4	89.4			x			
32	65.7	65.7		x					92	89.4	89.4			x			
33	68.0	68.0		x					93	89.2	89.2			x			
34	69.1	69.1		x					94	88.9	88.9			x			
35	69.5	69.5		x					95	88.5	88.5			x			
36	69.9	69.9		x					96	88.0	88.0			x		x	
37	70.6	70.6		x					97	87.5	87.5			x		x	
38	71.3	71.3		x					98	87.2	87.2			x		x	
39	72.2	72.2		x					99	87.1	87.1			x		x	
40	72.8	72.8		x					100	87.2	87.2			x		x	
41	73.2	73.2		x					101	87.3	87.3			x		x	
42	73.4	73.4		x					102	87.4	87.4			x		x	
43	73.8	73.8		x					103	87.5	87.5			x		x	
44	74.8	74.8		x					104	87.4	87.4			x		x	
45	76.7	76.7		x					105	87.1	87.1			x			
46	79.1	79.1		x					106	86.8	86.8			x			
47	81.1	81.1		x					107	86.4	86.4			x			
48	82.1	82.1				x			108	85.9	85.9			x			
49	81.7	81.7				x	x		109	85.2	85.2			x			
50	80.3	80.3				x	x		110	84.0	84.0				x		
51	78.8	78.8				x	x		111	82.2	82.2				x		
52	77.3	77.3				x	x		112	80.3	80.3				x		
53	75.9	75.9				x	x		113	78.6	78.6				x		
54	75.0	75.0				x	x		114	77.2	77.2				x		
55	74.7	74.7				x	x		115	75.9	75.9				x		
56	74.6	74.6				x	x		116	73.8	73.8				x		
57	74.7	74.7				x	x		117	70.4	70.4				x		
58	74.6	74.6				x	x		118	65.7	65.7				x		
59	74.4	74.4				x	x		119	60.5	60.5				x		
60	74.1	74.1		x			x		120	55.9	55.9				x		

Table 68: Cycle part 3, version 9 for vehicle class 3, 1 to 120 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
121	53.0	53.0				x			181	50.2	50.2				x		
122	51.6	51.6				x			182	48.7	48.7				x		
123	50.9	50.9				x			183	47.2	47.2				x		
124	50.5	50.5				x			184	47.1	47.1				x		
125	50.2	50.2		x					185	47.0	47.0				x		
126	50.2	50.2		x					186	46.9	46.9				x		
127	50.6	50.6		x					187	46.6	46.6				x		
128	51.2	51.2		x					188	46.3	46.3		x				
129	51.8	51.8		x					189	46.1	46.1		x				
130	52.5	52.5		x					190	46.1	46.1		x				
131	53.4	53.4		x					191	46.4	46.4		x				
132	54.9	54.9		x					192	47.1	47.1		x				
133	57.0	57.0		x					193	48.1	48.1		x				
134	59.4	59.4		x					194	49.8	49.8		x				
135	61.9	61.9		x					195	52.2	52.2		x				
136	64.3	64.3		x					196	54.8	54.8		x				
137	66.4	66.4		x					197	57.3	57.3		x				
138	68.1	68.1		x					198	59.5	59.5		x				
139	69.6	69.6		x					199	61.7	61.7		x				
140	70.7	70.7		x					200	64.3	64.3		x				
141	71.4	71.4		x					201	67.7	67.7		x				
142	71.8	71.8		x					202	71.4	71.4		x				
143	72.8	72.8		x					203	74.9	74.9		x				
144	75.0	75.0		x					204	78.2	78.2		x				
145	77.8	77.8		x					205	81.1	81.1		x				
146	80.7	80.7		x					206	83.9	83.9		x				
147	83.3	83.3		x					207	86.5	86.5		x				
148	85.4	85.4		x					208	89.1	89.1		x				
149	87.3	87.3		x					209	91.6	91.6		x				
150	89.1	89.1		x					210	94.0	94.0		x				
151	90.6	90.6		x					211	96.3	96.3		x				
152	91.9	91.9		x					212	98.4	98.4		x				
153	93.2	93.2		x					213	100.4	100.4		x				
154	94.5	94.5		x					214	102.1	102.1		x				
155	96.0	96.0		x					215	103.6	103.6		x				
156	97.5	97.5		x					216	104.9	104.9		x				
157	98.9	98.9		x					217	106.2	106.2		x				
158	99.8	99.8		x					218	107.4	106.4		x				
159	99.0	99.0				x			219	108.5	106.5		x				
160	96.6	96.6				x			220	109.3	106.6		x				
161	93.7	93.7				x			221	109.9	106.6		x				
162	91.3	91.3				x			222	110.5	107.0		x				
163	90.4	90.4				x			223	110.9	107.3		x				
164	90.6	90.6				x			224	111.2	107.3		x				
165	91.1	91.1				x			225	111.4	107.2		x				
166	90.9	90.9				x			226	111.7	107.2		x				
167	89.0	89.0				x			227	111.9	107.2		x				
168	85.6	85.6				x			228	112.3	107.3		x				
169	81.6	81.6				x			229	113.0	107.5		x				
170	77.6	77.6				x			230	114.1	107.3		x				
171	73.6	73.6				x			231	115.7	107.3		x				
172	69.7	69.7				x			232	117.5	107.3		x				
173	66.0	66.0				x			233	119.3	107.3		x				
174	62.7	62.7				x			234	121.0	108.0		x				
175	60.0	60.0				x			235	122.2	108.2		x				
176	58.0	58.0				x			236	122.9	108.9			x			
177	56.4	56.4				x			237	123.0	109.0			x			
178	54.8	54.8				x			238	122.9	108.9			x			
179	53.2	53.2				x			239	122.7	108.7			x			
180	51.7	51.7				x			240	122.6	108.6			x			

Table 69: Cycle part 3, version 9 for vehicle class 3, 121 to 240 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
241	122.4	108.4			x				301	109.8	95.8			x			
242	122.3	108.3			x				302	109.9	95.9			x			
243	122.2	108.2			x				303	110.2	96.2			x			
244	122.2	108.2			x				304	110.4	96.4			x			
245	122.2	108.2			x				305	110.7	96.7			x			
246	122.2	108.2			x				306	110.7	96.7				x		
247	122.3	108.3			x				307	110.3	96.3				x		
248	122.4	108.4			x				308	109.3	95.3				x		
249	122.4	108.4			x				309	108.0	94.0				x		
250	122.5	108.5			x				310	106.5	92.5				x		
251	122.5	108.5			x				311	105.4	91.4				x		
252	122.5	108.5			x				312	104.9	90.9				x		
253	122.5	108.5			x				313	104.7	90.7				x		
254	122.6	108.6			x				314	104.3	90.3				x		
255	122.8	108.8			x				315	103.6	89.6				x	x	
256	123.0	109.0			x				316	102.6	88.6				x	x	
257	123.2	109.2			x				317	101.7	87.7				x	x	
258	123.3	109.3			x				318	100.8	86.8				x	x	
259	123.4	109.4			x				319	100.2	86.2				x	x	
260	123.5	109.5			x				320	99.8	85.8				x	x	
261	123.5	109.5			x				321	99.7	85.7				x	x	
262	123.6	109.6			x				322	99.7	85.7				x	x	
263	123.8	109.8			x				323	100.0	86.0				x	x	
264	124.0	110.0			x				324	100.7	86.7		x			x	
265	124.2	110.2			x				325	101.8	87.8		x			x	
266	124.5	110.5			x				326	103.2	89.2		x			x	
267	124.7	110.7			x				327	104.9	90.9		x			x	
268	124.9	110.9			x				328	106.6	92.6		x			x	
269	125.1	111.1			x				329	108.3	94.3		x			x	
270	125.2	111.2			x				330	109.9	95.9		x			x	
271	125.3	111.3			x				331	111.4	97.4		x			x	
272	125.3	111.3			x				332	112.7	98.7		x			x	
273	125.3	111.3			x				333	113.7	99.7		x			x	
274	125.2	111.2			x				334	114.3	100.3		x			x	
275	125.0	111.0			x				335	114.6	100.6		x			x	
276	124.8	110.8			x				336	115.0	101.0		x			x	
277	124.6	110.6			x				337	115.4	101.4		x			x	
278	124.4	110.4			x				338	115.8	101.8		x			x	
279	124.3	110.3				x			339	116.2	102.2		x			x	
280	123.9	109.9				x			340	116.5	102.5		x			x	
281	123.3	109.3				x			341	116.6	102.6		x			x	
282	122.1	108.1				x			342	116.7	102.7		x			x	
283	120.3	106.3				x			343	116.8	102.8		x			x	
284	118.0	104.0				x			344	117.0	103.0		x			x	
285	115.5	101.5				x			345	117.5	103.5		x			x	
286	113.2	99.2				x			346	118.3	104.3		x			x	
287	111.2	97.2				x			347	119.2	105.2		x			x	
288	110.1	96.1				x			348	120.1	106.1		x			x	
289	109.7	95.7			x				349	120.8	106.8		x			x	
290	109.8	95.8			x				350	121.1	107.1				x	x	
291	110.1	96.1			x				351	120.7	106.7				x	x	
292	110.4	96.4			x				352	119.0	105.0				x	x	
293	110.7	96.7			x				353	116.3	102.3				x	x	
294	110.9	96.9			x				354	113.1	99.1				x	x	
295	110.9	96.9			x				355	110.3	96.3				x	x	
296	110.8	96.8			x				356	109.0	95.0				x	x	
297	110.6	96.6			x				357	109.4	95.4				x	x	
298	110.4	96.4			x				358	110.4	96.4				x	x	
299	110.1	96.1			x				359	111.3	97.3				x	x	
300	109.9	95.9			x				360	111.5	97.5				x	x	

Table 70: Cycle part 3, version 9 for vehicle class 3, 241 to 360 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
361	110.1	96.1				x	x		421	116.2	102.2			x			
362	107.4	93.4				x	x		422	116.4	102.4			x			
363	104.4	90.4				x	x		423	116.6	102.6			x			
364	101.8	87.8				x	x		424	116.8	102.8			x			
365	100.0	86.0				x	x		425	117.0	103.0			x			
366	99.1	85.1				x	x		426	117.4	103.4			x			
367	98.7	84.7				x	x		427	117.9	103.9			x			
368	98.2	84.2		x			x		428	118.4	104.4			x			
369	99.0	85.0		x			x		429	118.8	104.8			x			
370	100.5	86.5		x			x		430	119.2	105.2			x			
371	102.3	88.3		x			x		431	119.5	105.5			x			
372	103.9	89.9		x			x		432	119.7	105.7			x			
373	105.0	91.0		x			x		433	119.9	105.9			x			
374	105.8	91.8		x			x		434	120.1	106.1			x			
375	106.4	92.4		x			x		435	120.3	106.3			x			
376	107.1	93.1		x			x		436	120.5	106.5			x			
377	107.7	93.7		x			x		437	120.8	106.8			x			
378	108.3	94.3		x			x		438	121.1	107.1			x			
379	109.0	95.0		x			x		439	121.5	107.5			x			
380	109.6	95.6		x			x		440	122.0	108.0			x			
381	110.3	96.3		x			x		441	122.3	108.3			x			
382	110.9	96.9		x			x		442	122.6	108.6			x			
383	111.5	97.5		x			x		443	122.9	108.9			x			
384	112.0	98.0		x			x		444	123.1	109.1			x			
385	112.3	98.3		x			x		445	123.2	109.2			x			
386	112.6	98.6		x			x		446	123.4	109.4			x			
387	112.9	98.9		x			x		447	123.5	109.5			x			
388	113.1	99.1		x			x		448	123.7	109.7			x			
389	113.3	99.3		x			x		449	123.9	109.9			x			
390	113.3	99.3		x			x		450	124.2	110.2			x			
391	113.2	99.2		x			x		451	124.4	110.4			x			
392	113.2	99.2		x			x		452	124.7	110.7			x			
393	113.3	99.3		x			x		453	125.0	111.0			x			
394	113.5	99.5		x			x		454	125.2	111.2			x			
395	113.9	99.9		x			x		455	125.3	111.3			x			
396	114.3	100.3		x			x		456	125.1	111.1			x			
397	114.6	100.6		x			x		457	124.4	110.4			x			
398	114.9	100.9		x			x		458	123.3	109.3			x			
399	115.1	101.1			x				459	122.0	108.0			x			
400	115.3	101.3			x				460	120.8	106.8			x			
401	115.4	101.4			x				461	119.5	105.5			x			
402	115.5	101.5			x				462	118.4	104.4			x			
403	115.6	101.6			x				463	117.8	103.8			x			
404	115.8	101.8			x				464	117.6	103.6			x			
405	115.9	101.9			x				465	117.5	103.5			x			
406	116.0	102.0			x				466	117.5	103.5			x			
407	116.0	102.0			x				467	117.4	103.4			x			
408	116.0	102.0			x				468	117.3	103.3			x			
409	116.0	102.0			x				469	117.1	103.1			x			
410	115.9	101.9			x				470	116.9	102.9			x			
411	115.9	101.9			x				471	116.6	102.6			x			
412	115.9	101.9			x				472	116.5	102.5			x			
413	115.8	101.8			x				473	116.4	102.4			x			
414	115.8	101.8			x				474	116.4	102.4			x			
415	115.8	101.8			x				475	116.5	102.5			x			
416	115.8	101.8			x				476	116.7	102.7			x			
417	115.8	101.8			x				477	117.0	103.0			x			
418	115.8	101.8			x				478	117.3	103.3			x			
419	115.9	101.9			x				479	117.7	103.7			x			
420	116.0	102.0			x				480	118.1	104.1			x			

Table 71: Cycle part 3, version 9 for vehicle class 3, 361 to 480 s

	roller speed									roller speed							
time	normal	reduced speed	indicators						time	normal	reduced speed	indicators					
s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear	s	km/h	km/h	stop	acc	cruise	dec	no gear-shift	no 1. gear
481	118.5	104.5			x				541	115.0	101.0			x			
482	118.8	104.8			x				542	115.3	101.3			x			
483	118.9	104.9			x				543	116.0	102.0			x			
484	119.1	105.1			x				544	116.7	102.7			x			
485	119.1	105.1			x				545	117.5	103.5			x			
486	119.1	105.1			x				546	118.2	104.2			x			
487	119.2	105.2			x				547	118.6	104.6			x			
488	119.2	105.2			x				548	118.7	104.7			x			
489	119.3	105.3			x				549	118.8	104.8			x			
490	119.3	105.3			x				550	118.8	104.8			x			
491	119.4	105.4			x				551	118.9	104.9			x			
492	119.5	105.5			x				552	119.1	105.1			x			
493	119.5	105.5			x				553	119.4	105.4			x			
494	119.3	105.3			x				554	119.7	105.7			x			
495	119.0	105.0			x				555	119.9	105.9			x			
496	118.6	104.6			x				556	120.0	106.0				x		
497	118.2	104.2			x				557	119.6	105.6				x		
498	117.8	103.8			x				558	118.4	105.4				x		
499	117.6	103.6			x				559	115.9	103.9				x		
500	117.5	103.5			x				560	113.2	102.2				x		
501	117.4	103.4			x				561	110.5	100.5				x		
502	117.4	103.4			x				562	107.2	99.2				x		
503	117.3	103.3			x				563	104.0	98.0				x		
504	117.0	103.0			x				564	100.4	96.4				x		
505	116.7	102.7			x				565	96.8	94.8				x		
506	116.4	102.4			x				566	92.8	92.8				x		
507	116.1	102.1			x				567	88.9	88.9				x		
508	115.9	101.9			x				568	84.9	84.9				x		
509	115.7	101.7			x				569	80.6	80.6				x		
510	115.5	101.5			x				570	76.3	76.3				x		
511	115.3	101.3			x				571	72.3	72.3				x		
512	115.2	101.2			x				572	68.7	68.7				x		
513	115.0	101.0			x				573	65.5	65.5				x		
514	114.9	100.9			x				574	63.0	63.0				x		
515	114.9	100.9			x				575	61.2	61.2				x		
516	115.0	101.0			x				576	60.5	60.5				x		
517	115.2	101.2			x				577	60.0	60.0				x		
518	115.3	101.3			x				578	59.7	59.7				x		
519	115.4	101.4			x				579	59.4	59.4				x		
520	115.4	101.4			x				580	59.4	59.4				x		
521	115.2	101.2			x				581	58.0	58.0				x		
522	114.8	100.8			x				582	55.0	55.0				x		
523	114.4	100.4			x				583	51.0	51.0				x		
524	113.9	99.9			x				584	46.0	46.0				x		
525	113.6	99.6			x				585	38.8	38.8				x		
526	113.5	99.5			x				586	31.6	31.6				x		
527	113.5	99.5			x				587	24.4	24.4				x		
528	113.6	99.6			x				588	17.2	17.2				x		
529	113.7	99.7			x				589	10.0	10.0				x		
530	113.8	99.8			x				590	5.0	5.0	x					
531	113.9	99.9			x				591	2.0	2.0	x					
532	114.0	100.0			x				592	0.0	0.0	x					
533	114.0	100.0			x				593	0.0	0.0	x					
534	114.1	100.1			x				594	0.0	0.0	x					
535	114.2	100.2			x				595	0.0	0.0	x					
536	114.4	100.4			x				596	0.0	0.0	x					
537	114.5	100.5			x				597	0.0	0.0	x					
538	114.6	100.6			x				598	0.0	0.0	x					
539	114.7	100.7			x				599	0.0	0.0	x					
540	114.8	100.8			x				600	0.0	0.0	x					

Table 72: Cycle part 3, version 9 for vehicle class 3, 481 to 600 s