

Status Report on the Work of the WMTC Group

Transmitted by the WMTC Group

1. Current status on the work of the WMTC group

After the 7th FE meeting in Tokyo and the 5th informal meeting at 10th of June the current status of the WMTC work can be summarised as follows:

- The technical report delivered by the Netherlands (VROM) was distributed prior to the last FE meeting will be taken by the WMTC FE group as basis for the preparation of a WMTC report for GRPE. This report will include all relevant development steps, the validation test results and a proposal for a certification procedure. The WMTC group will deliver this report prior to the next GRPE meeting (45th meeting).
- One important part of the certification procedure will be the update of the test protocol on the basis of the report from the ISO WG 17 that was delivered in May 2002.
- After last discussions in the FE group the change of acceleration rate in the vehicle speed pattern was limited in order to improve driveability and reduce the risk of tyre slip. The corresponding modifications resulted in version 8 of the cycle. This version was confirmed as final version of the test cycle at the 5th informal meeting.
- In addition it was agreed to create a special version of cycle part 1 with a top speed of 50 km/h for motorcycles with 50 ccm engine capacity.
- The following unresolved issues still have to be discussed in more detail within the FE group:
 - o Vehicle classification,
 - o Weighting of the emission results of different cycle parts,
 - o Simplification of the developed gearshift prescriptions,
 - o Off cycle emission provisions.

Position papers regarding these open questions were already delivered to the FE group by 4 countries. In order to get a wider basis for the discussion in the next FE meeting other countries and organisations are invited to deliver additional position papers until mid of September 2002.

- The attached timetable (see page 12) shows that all information and specifications required for the round robin test will be available on schedule, so that the round robin test can be started in January 2003.
- The results of the validation tests (see chapter 2) form a very important basis for the discussions on the unresolved issues because the database is large enough to enable a technical discussion on the WMTC work.

2. Overview of the results of the validation test measurements (Extract from the technical report delivered by the Netherlands (VROM))

2.1 Vehicle sample and test design

To be able to start the validation test 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, version 7 (see Figure 1),
- Appropriate regional certification cycle according to the corresponding measurement procedure

For Europe the test cycle as described in COM 2000 314 final Commission proposal for amendment of 97/24, sec. 5.3.1, Appendix 1 should be used. Additional cycles like the European passenger car test cycle (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.

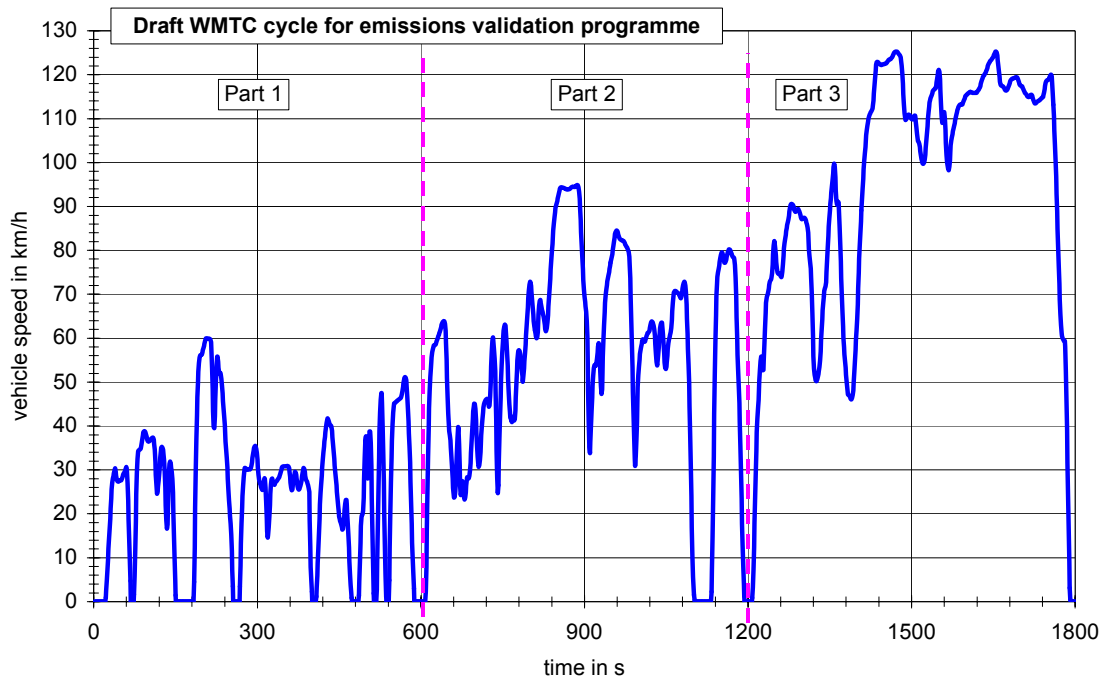


Figure 1: Draft WMTC driving cycle, version 7

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 max. speed was reached.

Since the FE group did not find a compromise concerning vehicle classification, it was decided to postpone a final decision till the analysis of the emissions validation test results will have been finished and to use the following provisional vehicle classification for the emissions validation tests in order to get a broader database for the discussion:

- Part 1 mandatory for all vehicles,
- Part 2 mandatory if $v_{\max} \geq 80$ km/h,
- Part 3 mandatory if $v_{\max} \geq 120$ km/h

v_{\max} is the maximum vehicle speed as declared by the manufacturer.

The following results should be delivered:

- Technical data of the vehicle including v_{\max} ,
- 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:

1. Some participants were not able to measure emissions with 1 Hz resolution,
2. The road load setting requirements were not fulfilled,
3. The provisional vehicle classification was not met,
4. The speed tolerances were not met,
5. Only bag results were delivered,
6. The wrong cycle version was used.

But 90% of the results could be used for further analysis. Table 1 shows an overview of the vehicle sample distribution for different regions and provisional vehicle classes. 83% 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 1: Vehicle sample for the emissions validation test programme

Table 2 gives an overview of the distribution of engine type and reduction system within the vehicle sample.

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

2.2 Comparison of the Results for WMTC and ECE R 40/TRIAS

A preliminary overall result of the WMTC was calculated by adding the emissions of all cycle parts except part 1 hot and dividing the total emission by the total distance of all cycle parts. These results are compared to the ECE R 40 and TRIAS results. TRIAS is the certification cycle in Japan that is based on the ECE cycle with modified gearshift points.

Figure 2 shows the comparison for HC emissions and all vehicles. The resolutions of the axes are determined by the results for 2-stroke vehicles that are substantially higher than those of the 4-stroke vehicles. The average values of the WMTC are lower than the average results of ECE R 40. If one vehicle with an extreme high ECE R 40 result is excluded the correlation for 2-stroke vehicles results in a one by one line.

To achieve a better resolution of the 4-stroke vehicle results, these are shown separately in Figure 3. The major part of the results is below 1 g/km. In this region the WMTC results are a bit higher than the ECE R 40 results. For higher values it is the other way round. A one by one correlation performs still an acceptable compromise.

This is also the case for CO emissions (see Figure 4) although the slope of the regression line for class 3 vehicles is 16% higher and for class 1, 2-stroke vehicles 16% lower than 1.

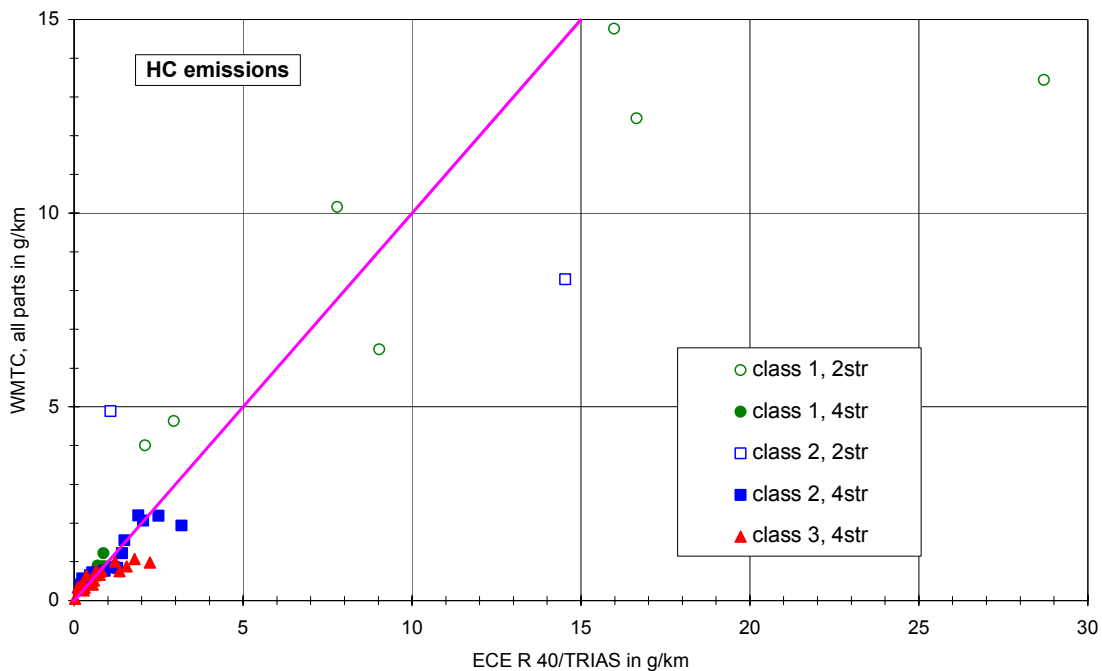


Figure 2: Comparison of the provisional WMTC results and the ECE R 40/TRIAS results for HC (2-stroke and 4-stroke vehicles)

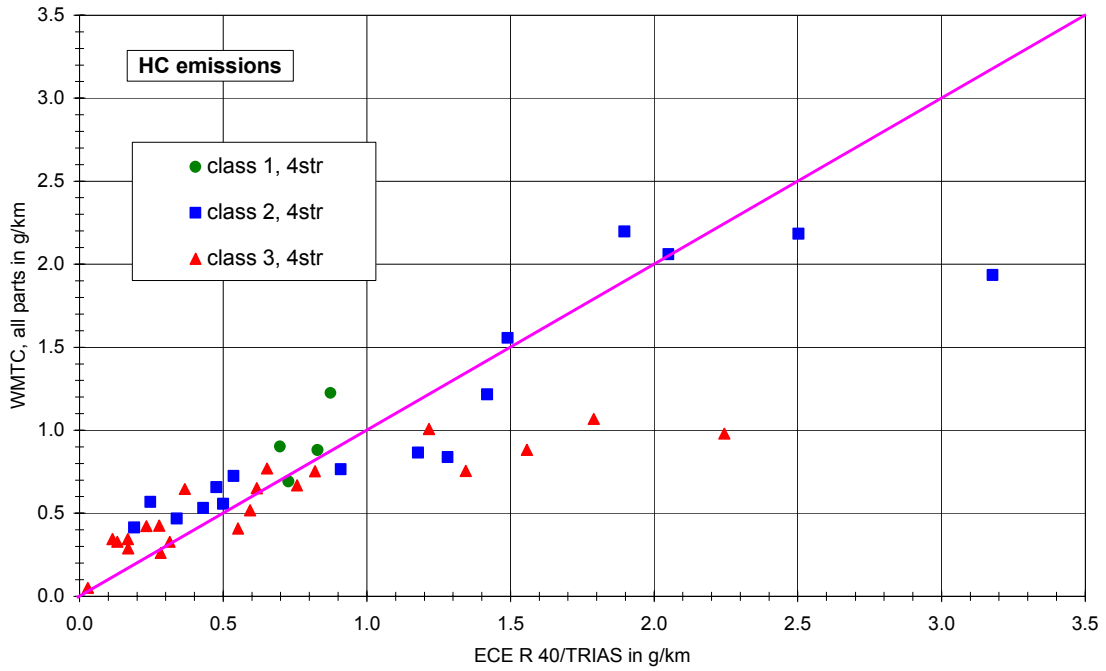


Figure 3: Comparison of the provisional WMTC results and the ECE R 40/TRIAS results for HC (4-stroke vehicles only)

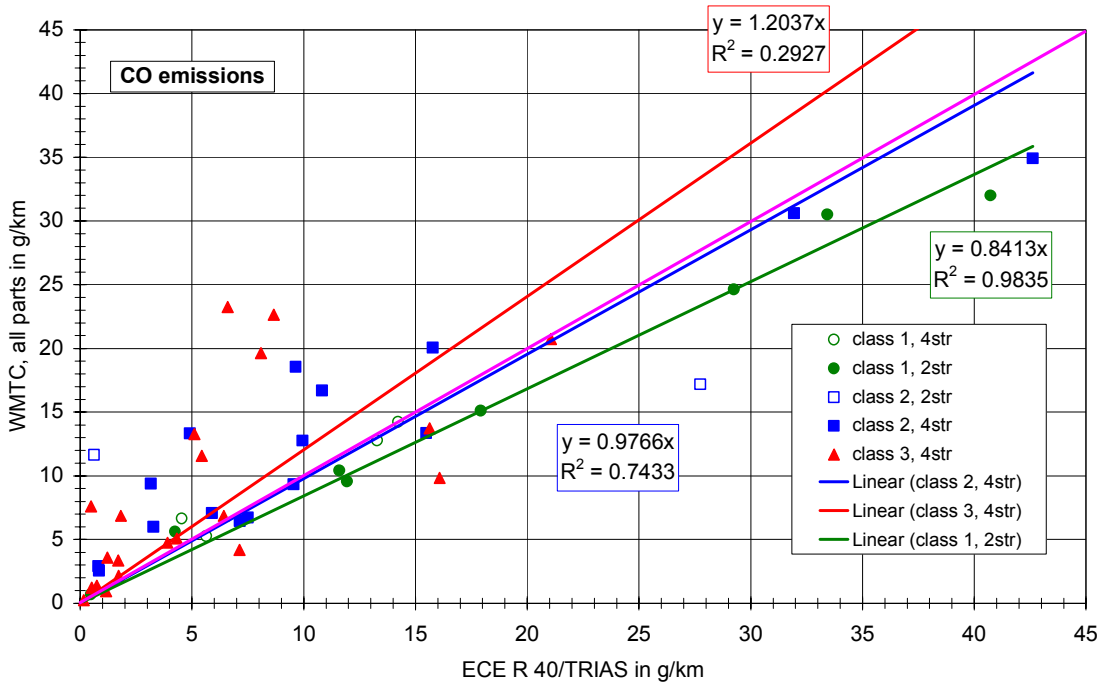


Figure 4: Comparison of the provisional WMTC results and the ECE R 40/TRIAS results for CO

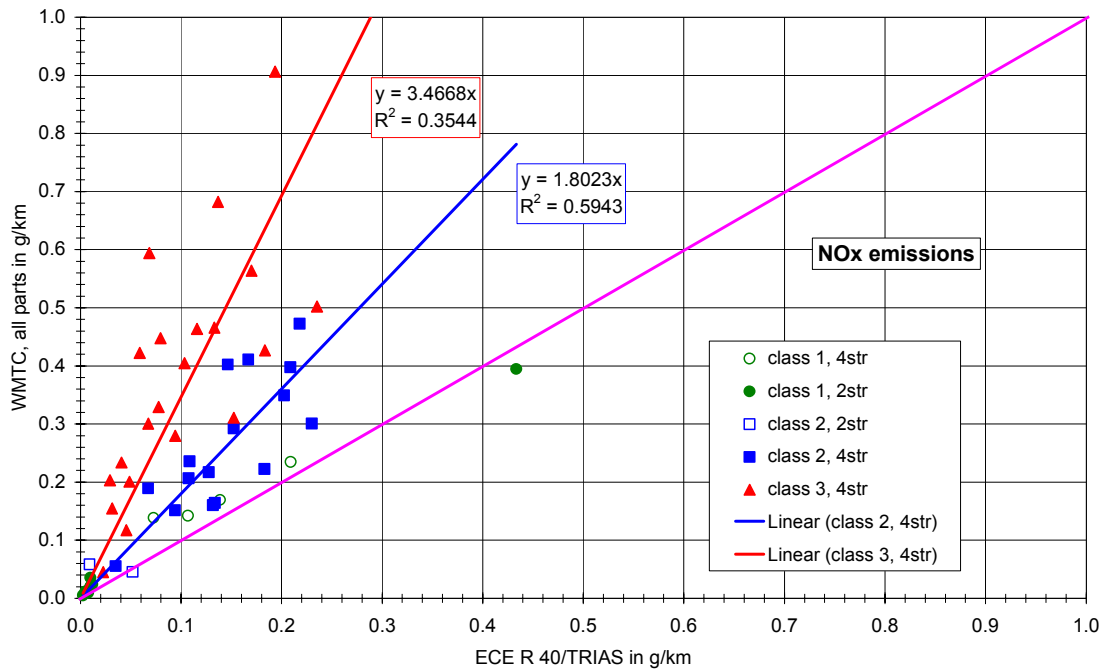


Figure 5: Comparison of the provisional WMTC results and the ECE R 40/TRIAS results for NOx

As expected the NOx emissions results show higher differences (see Figure 5) that can be allocated to the different max. speeds of the WMTC cycles for the provisional vehicle classes. A one by one relation would be acceptable for class 1, but the emissions of the WMTC cycle for class 2 and class 3 vehicles are substantially higher than those of the ECE R 40 test. The slope of the regression line for class 2 vehicles is 1,8; the slope of the regression line for class 3 vehicles is 3,5.

2.3 Comparison of the Results for WMTC and US FTP

A similar comparison was performed for the WMTC and the US-FTP cycles. This could only be done for 6 vehicles, 2 of them measured in the US and 4 of them in Japan. The results are shown in Figure 6 to Figure 8. The tendencies are similar to what was mentioned in the previous chapter.

2.4 Comparison of the Results for WMTC and NEDC

In addition measurement results for the new European driving cycle for cars (NEDC) were delivered for 24 vehicles. Since this cycle is currently under discussion to be used on a mid term perspective also for motorcycles a comparison with the WMTC results are included in this report.

The results are shown in Figure 9 to Figure 11. Some of these vehicles did not reach the max. speed of the NEDC and/or WMTC parts 2 or 3. These cases are indicated by different symbols. They do not show significant deviations from the trend for all other vehicles, although even a Pclass 1 vehicle is included.

For HC and CO emissions and low emission values there is a one by one relation between both cycles. For NOx this is only the case for vehicles belonging to Pclass 1 or Pclass 2. For Pclass 3 the WMTC values are significantly higher (the slope of the regression line is 1,6), because the vehicle speed distribution of the WMTC has substantially higher frequencies for high speeds than the NEDC.

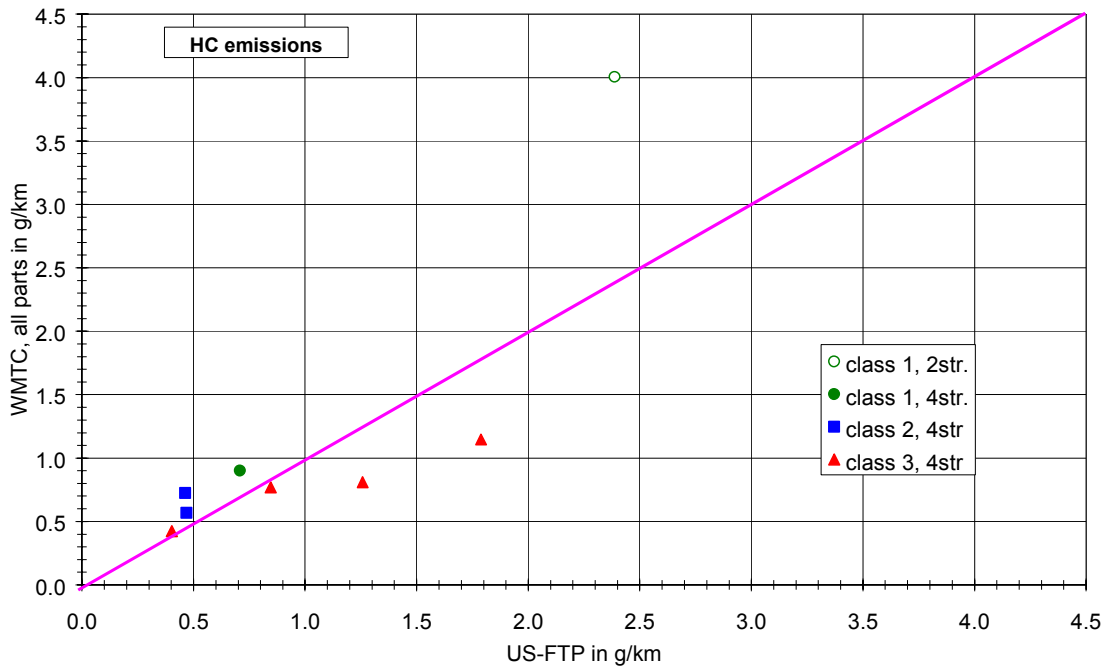


Figure 6: Comparison of the provisional WMTC results and the US FTP results for HC

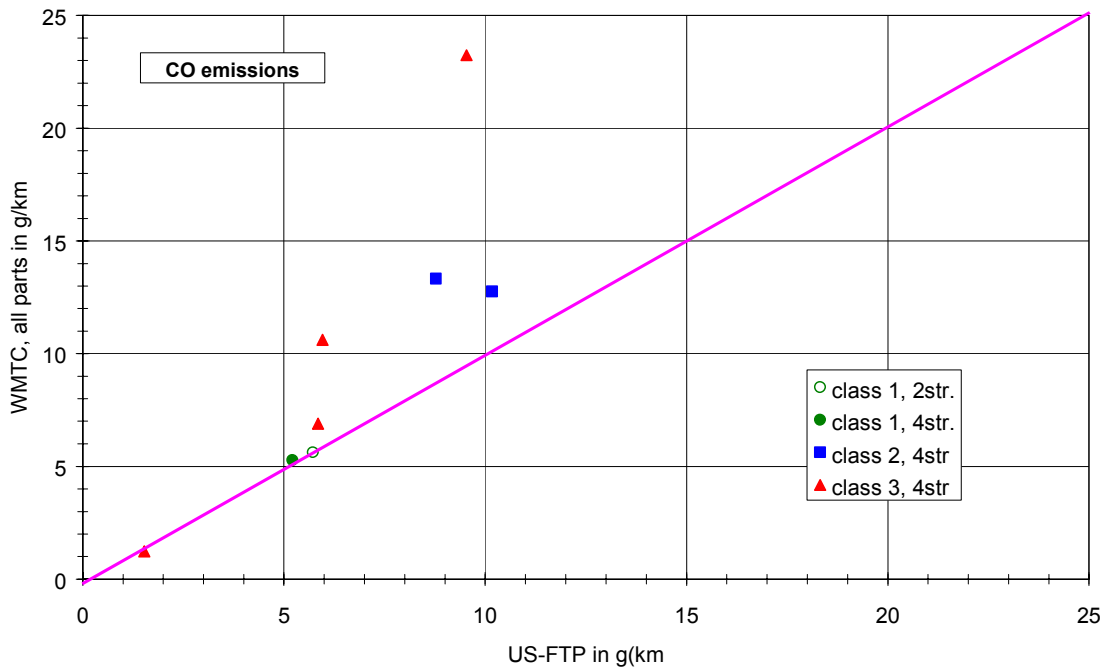


Figure 7: Comparison of the provisional WMTC results and the US FTP results for CO

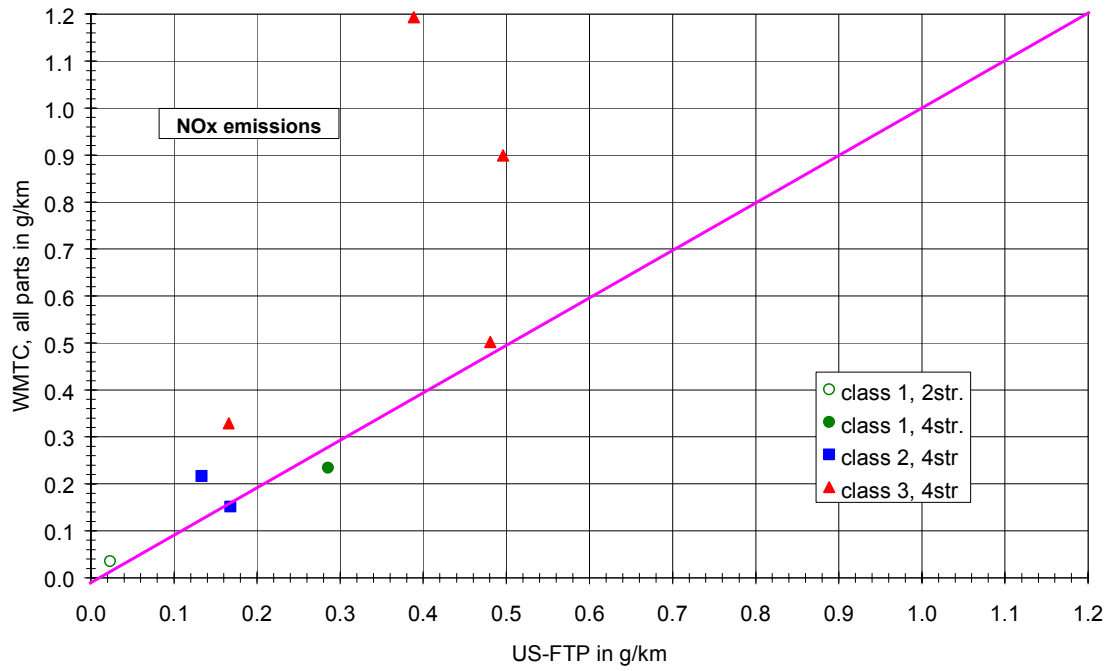


Figure 8: Comparison of the provisional WMTC results and the US FTP results for NOx

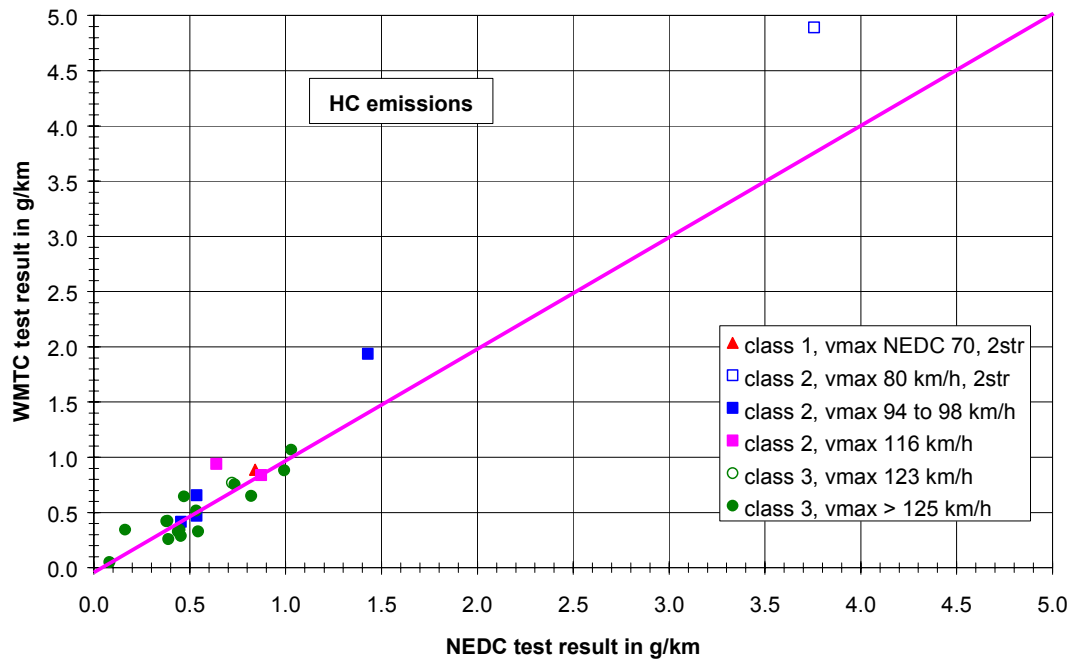


Figure 9: Comparison of the provisional WMTC results and the NEDC results for HC

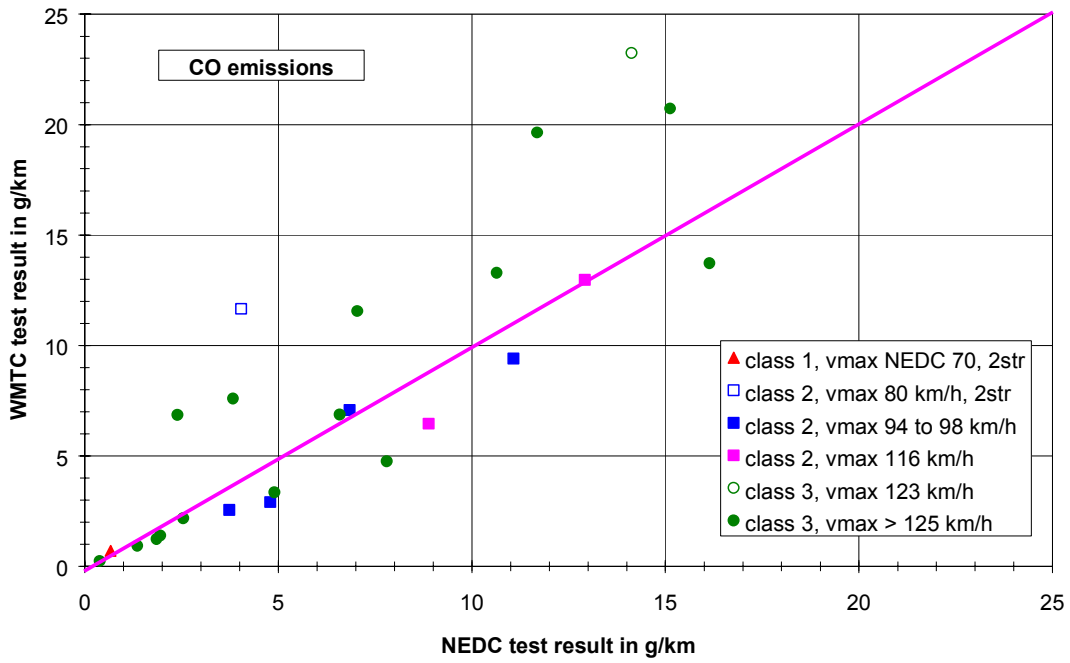


Figure 10: Comparison of the provisional WMTC results and the NEDC results for CO

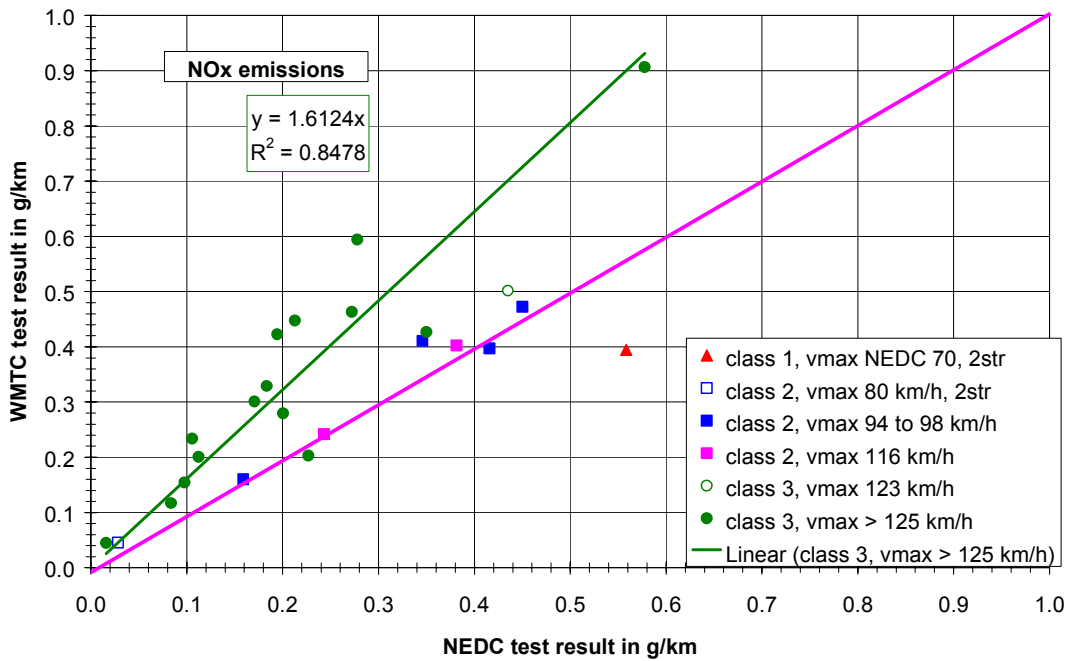


Figure 11: Comparison of the provisional WMTC results and the NEDC results for NOx

2.5 Summary of Results of a detailed Analysis with respect to Variances and Emission Components

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 maximum roller speed is below max 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.

HC emissions:

WMTC part1, cold is typically higher than ECE/TRIAS, oxicat reduction for 2stroke is substantially lower for WMTC than for ECE/TRIAS, emissions of vehicles with air injection on average higher than of vehicles with no reduction system, WMTC part 1 result for several vehicles determined by the cold start emissions

CO emissions:

WMTC part1, cold is lower than ECE/TRIAS for 2stroke vehicles and 4stroke with no reduction system and higher than ECE/TRIAS for all other groups. Extreme variances exist for 4stroke vehicles without reduction system. For some of them the emissions are below the average for vehicles with 3w cat.

NOx emissions:

WMTC part 1 typically higher in average as well as in range than ECE/TRIAS, WMTC part 1 average of 4stroke vehicles without reduction systems nearly the same as for 4stroke vehicles with 3w cat, WMTC 1-3 results for vehicles with oxicat and air injection nearly the same, minimum level for WMTC 1-3 for vehicles without reduction system below average for vehicles with 3w cat.

		2002												2003						
		Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	Apr.	May	June	
	Step	Task																		
	1a	remonitoring of statistics about vehicle stock and use																		
	1b	in-use data (completed)																		
	2a	cycle development (completed)																		
	2b	gearshift prescription development																		
	3a	driveability																		
	3b	update of measurement procedure																		
	3c	emissions validation tests																		
	3d	analysis of emissions results																		
	3e	classification																		
	3f	weighting factors																		
	4a	road load resistance																		
	4b	def. of inertia mass																		
	4c	cooling requirements																		
	4d	exhaust gas sampling procedure																		
	5	Final measurement procedure (test protocol including cycle, gearshift presor., add. Specifications)																		
	6	off cycle emissions provisions																		
	7a	preparation of round robin test																		
	7b	round robin test																		
	7c	analysis of results																		
	8	Test procedure. Proposal for GTR Incl. Off cycle emissions provisions)																		
		reports																		
		technical report by VROM																		
		1. draft WMTC report																		
		Report to GRPE																		
		Position paper																		
		Position paper																		
		Position paper																		
		prerequisite for round robin test																		

Timetable