Submitted by the WLTP Drafting Group	Working paper No. **WLTP-03-03** (3rd WLTP meeting, 10 June, 2009)

Proposed Roadmap on WLTP

(Worldwide Harmonized Light-Duty Test Procedure)

Contents

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Appendix

Project plan (WLTP-03-04) and estimated resources (WLTP-03-05)

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This proposed roadmap was developed during the WLTP drafting group meetings hosted by European Commission on 19th March and 27th&28th April 2009. Participating contracting parties and organizations were the European Commission, Japan, UK, Germany, France, NL, Sweden, India, USA, FIA, AECC, OICA and the WLTP Technical Secretary.

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I. Objectives

In its November 2007 sessions, WP.29 decided to set up an informal group under GRPE to prepare, within the next 2 years, a roadmap for a development of the worldwide harmonized light-duty test procedure (WLTP).

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During two informal group meetings on WLTP (4th June 2008 and 14th January 2009), the following was agreed by the contracting parties and related organizations:

- the roadmap is expected to be proposed by June 2009 to accelerate the WLTP gtr development
- the deadline for the gtr development (Phase I work) was set to be the end of 2013
- the list of items to be included in WLTP work frame

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As agreed in previous discussions during WP.29 and WLTP informal group meetings, the objectives of this roadmap are

- to define the scope of work to develop a gtr
- to clarify the time schedule and the time frame of each work element
- to provide a plan for future work
- to estimate the expected resources (manpower and budget)

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II. Scope of work

The following was agreed during the 2nd WLTP informal group meeting (14th January 2009):

- the impact of MAC (mobile air conditioning) use should be accounted for in the procedure

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- a broad range of power sources (LPG, CNG, FFV, H2, HEV, EV) should be covered
- type approval / certification procedures should be excluded but agreement will be required on what elements constitute such procedure
- OBD issues should be addressed either at a later stage by the WLTP gtr or in a separate gtr

During the 148th WP.29/AC.3 meeting (June 2009) it will be decided to include or to exclude the following work elements, however, they will be included in this roadmap pending WP.29's decision.

- durability
- in-service conformity

The work will be divided into three phases with the aim of completing the Phase I work by the end of 2013. During each phase, the following elements will be developed.

1. Phase I :
   - worldwide harmonized light duty driving cycle and associated test procedure for common measurement of pollutants, CO2 and fuel consumption and compatible for OBD demonstration
   - off-cycle requirements
   - MAC (mobile air conditioning) test procedure

2. Phase II :
   - low temperature / high altitude test procedure
   - durability
   - in-service conformity
   - OBD

3. Phase III :
   - emission limit values and OBD thresholds
   - reference fuel properties
   - correlation with existing regional cycles

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III. Overall Schedule

1. Phase I : propose a gtr to the 161st WP.29/AC.3 (November 2013)
2. Phase II : propose a addition to the gtr to the 175th WP.29/AC.3 (March 2018)
3. Phase III : start activities from 2018

For more detail, please refer to WLTP-03-04

IV. Phase I Work

1. Organisation for Phase I

For organisational reasons, it was agreed to set up four sub-groups which will report to the WLTP informal group. In addition to these technical sub-groups, the text drafting group will work , on the gtr text development.

- ✧ WLTP informal group
  - chaired by Mr. Gauvin
  - secretary : Mr. Ichikawa
- ➢ Technical groups for Phase I
  - ✓ DHC (development of worldwide harmonized light duty driving cycle)
    - chaired by _____
    - mandate : develop worldwide harmonized light duty driving cycle
  - ✓ DTP (development of test procedure)
    - chaired by _____
    - mandate : develop worldwide harmonized light duty test procedure
  - ✓ OCE (off-cycle emission)
    - chaired by _____
    - mandate : develop off cycle test procedure
  - ✓ MAC (mobile air conditioning)
    - chaired by _____
    - mandate : develop MAC test procedure

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- ➢ text drafting group
  - chaired by _____
  - mandate : develop WLTP gtr

2. Phase I schedule

Please refer to WLTP-03-04

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3. Development of worldwide harmonized light duty driving cycle: each work element will be executed by the DHC group. Due to the tight schedule, this work should start in June. 2009 just after WP.29 approval of the roadmap in its 148th meeting.

A. In-use data collection [1.1.1.] (note : correspond to number in WLTP-03-04)
Five contracting parties (European Commission, China, India, Japan and USA) have committed to participate in the in-use data collection program. The FIA Foundation have volunteered to finance data sampling in South America, and data from industry will be taken into account.
Vehicle classes and road categories will be defined before data collection. Each region will decide on typical vehicle and route composition for each class.

a. Preparation [1.1.1.1.]
The following elements need to be fixed prior to data collection:
- review currently available data [1.1.1.1.1.]
- definition/selection of test vehicles (consider also hybrid / electric / gas vehicles etc.) [1.1.1.1.2.]
- definition/selection of area, road types, test conditions & route [1.1.1.1.3.]
- planning of data collection (e.g. What data? What frequency? Chase car vs. instrumented vehicle etc.) [1.1.1.1.4.]
- statistical data [1.1.1.4.]
  - the number of vehicles
  - total annual mileage
  - characteristic use per type of road

b. Data collection [1.1.1.2.]
Data collection in the European, China, India, Japan, USA and South America will be executed with the support of the DHC group. Data collection should cover extreme conditions, MAC usage and “off cycle” usage, independent of their allocation to phases of the project.

c. Data check and review [1.1.1.3.]
The DHC group will check and review the data collected and if necessary, request that the particular contracting parties conduct additional data collection.

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B. Data analysis methodology [1.1.3.]

This is one of the key elements to develop the worldwide harmonized light duty driving cycle. Based on previous experience in WHDC, WMTC and other cycle developments (LA#4, JC08 etc.), the DHC group should develop the methodology and propose it to the WLTP informal group for acceptance. [1.1.3.1./1.1.3.2.]The following elements will, in particular, need to be considered:

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- definition of “representative”?
- weighting factor (urban/rural/motorway)
- weighting factor (regions)
- parts classification (speed? area?)
- driving / idling profile
- short trip profile (average speed/acceleration/...)
- 4 mode analysis (stop, acceleration, deceleration, cruise)
- total mode duration (urban/rural/motorway)
- number of short trips/idling period
- extract appropriate short trips (chi-squared based analysis, others)
- cold / hot start
- gear shift points
- verification

C. Worldwide harmonized light duty driving cycle development [1.1.4.]

This work will consist of two major steps. The first step will be to develop the initial driving cycle based on in-use data collection and data analysis methodology [1.1.3.]. Further iterations of the cycle will be necessary before the second step which would finalize the driving cycle based on the validation [1.1.5.], confirmation [1.1.6.2.] and round robin [1.1.6.3.] test results. The following elements should be considered in each step:

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- mode structure [1.1.4.1.1.]
- mode duration [1.1.4.1.2.]
- weighting factor (urban/rural/motorway) [1.1.4.1.3./1.1.4.2.1.]
- number of short trip / idling [1.1.4.1.4.]
- gear shift points [1.1.4.1.5./1.1.4.2.3.]
- arrangement of short trip / idling [1.1.4.2.2.]
- cold / hot start weighting factor [1.1.4.2.4.]
- OBD impact [1.1.4.1.6.]

4. Test procedure development [1.2.2.]

This work element will be executed by the DTP group. ISO should be tasked with developing a standard for the test procedure in consultation with GRPE. In a preliminary step a common terminology will need to be defined [1.2.1.]. Then the following elements should be considered:

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- Test procedure [1.2.2.]
  - emission constituents [1.2.2.1.]
  - energy consumption [1.2.2.10]
  - IW class (including vehicle masses) [1.2.2.2.]
  - road-load measurement [1.2.2.3.]
  - electric load [1.2.2.5.]
  - pre-conditioning/state of charge [1.2.2.4.]
  - calculation formulae [1.2.2.6.]
  - hybrid vehicles [1.2.2.8.]
  - electric vehicles [1.2.2.9.]
  - flex fuel vehicles [1.2.2.7.]
  - gas fuelled vehicles [1.2.2.7.]
  - gear shift points where not prescribed by drive cycle [1.2.2.11.]
  - List of required reference fuels [1.2.2.12.]
- test equipment [1.2.3.]
  - chassis dynamometer [1.2.3.1.]
  - analyzer / CVS / dilution tunnel [1.2.3.2.]
  - others (fan, cylinder gas, SHED,....) [1.2.3.3.]
  - economic consequences [1.2.3.4.]
- final modifications [1.2.4.]

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5. Off cycle requirements [1.3.]

Each work element will be executed by the OCE group. The OCE group will develop the off cycle requirements including the definition of off cycle [1.3.1.]. The OCE group should have a close link with the DHC group for in-use data collection and off cycle development, if applicable. The following elements should be considered:

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- develop OCE methodology and candidates for off cycle mode [1.3.1.]
  - OCE methodology [1.3.1.1.]
  - OCE mode (extra driving cycle, NTE, PEMS, …) [1.3.1.2.]

- evaluation of OCE candidates mode [1.3.2.]
  - defeat device strategy [1.3.2.1.]
  - deficiencies [1.3.2.2.]
  - exemption area [1.3.2.3.]
  - extreme ambient conditions [1.3.2.4.]
  - driver selectable switch [1.3.2.5.]
- test method [1.3.3.]
  - driving mode [1.3.3.1.]
  - engine mapping [1.3.3.2.]
- develop test procedure [1.3.4.]
- OBD impact [1.3.5.]
- Validation test [1.3.6.]
  - test vehicle selection [1.3.6.1.]
  - procure vehicles [1.3.6.2.]
  - testing [1.3.6.3.]
- economic impact

6. MAC (mobile air conditioning) [1.4.]

- This work element is will be executed by the MAC group. Currently only one test procedure (SC03 in USA) exists the regulation and several methods are in the process of study [1.4.1.]. In consideration of repeatability, vehicle size, test ambient conditions and reliability of test results, the following elements should be considered for the MAC evaluation procedure [1.4.2.]:

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- influence on exhaust gas emissions and fuel consumption / CO2
- system assessment [1.4.2.1.]
  - use of full vehicle environmental cell [1.4.2.1.1.]
  - use of test bench AC component [1.4.2.1.2.]

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- develop the physical MAC test procedure [1.4.2.2.]
  - develop test procedure [1.4.2.2.1.]
  - influence on emissions and fuel consumption [1.4.2.2.2.]
  - OBD impact [1.4.2.2.3.]
- develop the virtual MAC test procedure [1.4.2.3.]
  - AC system evaluation [1.4.2.3.1.]
  - simulation [1.4.2.3.2.]
  - influence on emissions and fuel consumption [1.4.2.3.3.]
- economic impact and validation test [1.4.2.4.]

- modification if necessary [1.4.2.5.]

7. Validation tests [1.1.5.]

This work element will be executed by the DHC group. The DTP group should be involved to provide a new test procedure. This work consists of three steps. The first step will be a preparation phase [1.1.5.1.] consisting of the following stages:

- definition of test items [1.1.5.1.1.]
- definition of test vehicle matrix [1.1.5.1.2.]
- procure test vehicles [1.1.5.1.3.]
- test site preparation [1.1.5.1.4.]

The second step [1.1.5.2.] will be a preliminary check on the newly developed driving cycle under the current test procedures. The third step [1.1.5.3.] will be a precise check under the proposed new test procedure. The following elements should be considered in each step:

- test items / test vehicle matrix
- test site preparation
- drivability
  - smooth throttle operation
  - appropriate shift point
  - clutch off point
  - mode traceability, slip
- repeatability
- OBD compatibility & demonstration principle, check that the drive cycle does not force changes to systems that would function adequately "in the real world"

According to the validation test results and conclusions from these, the newly developed driving cycle might be modified.

8. Confirmation tests [1.1.6.]

The purpose of confirmation tests is to determine whether or not the new test procedure (including new driving cycles) can be conducted with existing current test equipment in specific laboratories. This work element will be executed by DHC group, participating contracting parties, independent and industry emission laboratories after completion of the first step of validation tests. The following elements will be considered:

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- test items / test vehicle matrix [1.1.6.1.1./1.1.6.1.2.]
- procure test vehicles [1.1.6.1.3.]
- test site preparation [1.1.6.1.4.]
- perform a series of test procedures [1.1.6.2.]
- confirm practicability and reproducibility [1.1.6.2.]

The results of these activities may lead to small modifications of the driving cycle [1.1.6.4.].

9. Round robin tests [1.1.7.]

In parallel to the confirmation tests, round robin tests will be conducted to check the correlation between laboratories under the new test procedure. This work element will be executed by the DHC group, participating contracting parties, independent and industry emission laboratories. The round robin cannot begin until the newly developed driving cycle has been finalized late in Phase I. Consequently it will be necessary to find a means of constraining the duration of the round robin in order to meet the Phase I deadline.The following elements will be considered:

- test items / test vehicle matrix [1.1.7.1./1.1.7.2.]
- procure test vehicles [1.1.7.3.]
- perform a series of test procedures [.1.1.7.4.]
- confirm practicability and reproducibility [1.1.7.5.]
- correlation check between laboratories [1.1.7.5.]

10. Development of gtr text [1.5.]

This work element will be executed by the text drafting group in close co-operation with the technical groups. The following elements will be considered:

- generate overall gtr structure
- combine all technical group works
- develop gtr text and legal documents required by WP.29 agreement
- impact assessment [1.6.]

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V. Phase II Work

1. Organization during Phase II

✧ WLTP informal group
- chaired by : _____
- secretary : _____

➢ technical groups

✓ conformity group
- chaired by _____
- mandate : develop test procedures for durability demonstration, CoP and ISC

✓ OBD group
- chaired by _____
- mandate: develop OBD test procedure

➢ text drafting group
- chaired by _____
- mandate : develop WLTP gtr extension/OBD gtr text (if necessary)

2. Phase II schedule

Please refer to WLTP-03-04.

3. Low ambient temperature [2.2.] / high altitude [2.3.] tests

This work element will be executed , mainly by the DTP group. The DHC group may be involved if specific driving cycles will be required. The following elements should be considered:

➢ Specific test cycle (DHC group) : The worldwide harmonized light duty driving cycle is expected to be the base cycle under these conditions. However, it might be necessary to develop a specific driving cycle if validation tests indicate a critical problem. Therefore this work may be a part of Phase II.

➢ Test conditions (DTP group) [2.2.1./2.3.1.] :
- set test conditions (temperature, humidity, pressure, etc.)
- modify target road-load based on air density difference

➢ The definition of specific fuels must be investigated [2.2.2./2.3.2.]

➢ Optional requirement: it will be up to each contracting party whether or not to adopt these requirement according to its circumstances.

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4. Conformity [2.4.]

4.1. Durability [2.4.1.]

This work element will be executed by the conformity group. In an initial step it will have to be considered if all of the following elements are needed: durability demonstration tests, conformity of production (CoP), and in-service conformity test (ISC).

Currently three methods exist for durability test procedures. The following elements will be considered:

a. whole vehicle durability test [2.4.1.1.]
- review current and new WLTP cycle [2.4.1.1.]
- (develop durability driving cycle, if necessary) [2.4.1.1.]
- test points [2.4.1.2.]
- test fuel [2.4.1.3.]

b. bench aging test [2.4.1.2.]
- define emission control components [2.4.1.2.1.]
- develop bench aging method [2.4.1.2.2.]
- test fuel [2.4.1.2.3.]

c. development of the test procedure [2.4.1.3]

d. validation test [2.4.1.4]

e. assigned deterioration factors [2.4.1.5.]

4.2. Conformity of production and in-service conformity [2.4.2.]

The following elements will be considered:

a. Vehicle selection criteria [2.4.2.1.]
- define engine family [2.4.2.1.1.]
- rejection criteria [2.4.2.1.2.]
- number of test vehicles [2.4.2.1.3.]
- odometer criteria [2.4.2.1.4.]

b. In-service testing [2.4.2.2.]
- as-received condition [2.4.2.2.1.]
- OBD information [2.4.2.2.2.]

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- conduct maintenance if necessary [2.4.2.2.3.]
- second test if necessary [2.4.2.2.4.]
- measured emission constituents [2.4.2.2.5.] (exhaust, CO2, evaporative, ...)
- test fuels [2.4.2.2.6.]

c. Pass/fail judgment [2.4.2.3.]
- number of samples [2.4.2.3.1.]
- pass/fail methodology [2.4.2.3.2.]
- engine family [2.4.2.3.3.]

d. Validation if based on new concept [2.4.2.4]

e. final text [2.4.2.5.]

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5. OBD [2.1.]

This work element will be executed by the OBD Group. The basis for harmonization will be existing OBD regulations [2.1.1.] such as:

- WWH-OBD
- US California Regulation
- US Federal Regulation
- EU Regulation
- Japanese Regulation

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The following elements should be considered:
- OBD specific definitions (e.g. drive cycle, warm up, etc) [2.1.2.1.]
- purpose and limitations [2.1.2.2.]
- monitoring requirements [2.1.2.3.]
  - malfunction criteria determination
  - monitoring conditions, monitoring cycle, off-cycle
- demonstration [2.1.2.4.]
  - fuel impact
  - test procedure
  - demonstration cycle, preconditioning cycle
  - in-use performance
- information [2.1.2.5.]
  - driver information

- data storage and transmission
- standardization
- documentation
- production vehicle evaluation
- exceptions, deficiencies

The text development [2.1.2.] will be supported by validation tests [2.1.3.] with the following steps:

- procure test vehicles [2.1.3.1.]
- validation on a test bench [2.1.3.2.]
- in-field validation tests [2.1.3.3.]

6. Development of gtr text for Phase II [2.6.]

This work element will be executed by the text drafting group in close co-operation with the technical groups. The following elements should be considered:

- generate overall gtr structure [2.6.1.]
- combine all technical group works
- develop gtr text and legal document demanded by WP.29 agreement [2.6.2]
- editorial check
- impact assessment [2.6.3.]

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VI. Phase III Work

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It was agreed during the WLTP drafting group meetings to consider harmonized emission limits in conjunction with fuel properties in Phase III. An essential element for this phase will be a technical correlation study (comparison of emission results vehicles measured on vehicles following current regional requirements and the new gtr).

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Therefore the following steps are planned for Phase III:

- definition of reference fuel specifications [3.1.]
- correlation testing [3.2.]
  - test vehicles [3.1.1.]
  - procure test vehicles [3.1.2.]
  - comparative testing [3.1.3.]
- definition of emission limits and OBD thresholds [3.3.]
- development of final gtr text [3.4.]
- impact assessment [3.5.]

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VII. Reporting and Milestones

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1. Reporting

Session	Date	Report	Content
58th GRPE	Jun 09	I-58	0.1 Propose Roadmap and Acceptance
59th GRPE	Jan 10	I-59	1.1.1.1. Preparation
			1.1.3.1. Initial data analysis methodology
			1.3.1.1. OCE methodology
60th GRPE	Jun 10	I-60	1.1.1.2 Data collection
			1.1.3. Final data analysis methodology
			1.2.1. Terminology
			1.3.1.2. OCE mode definition
Interim IGM*	Aug 10	I-IG Aug10	1.1.1.3 Data check and review
*)Informal Group Meeting			1.1.1.4 Statistical data
61st GRPE	Jan 11	I-61	1.4.2.1. MAC system assessment
Interim IGM	Apr 11	I-IG Apr 11	1.1.4.1. Development of initial mode
62nd GRPE	Jun 11	I-62	1.1.5.1. Validation test preparation
			1.3.2. Evaluation of candidate off-cycle mode
Interim IGM	Oct 11		1.1.5.2 Validation 1 (current test procedure)
			1.2.2 Initial test procedure
			1.2.3 Initial test equipment
63rd GRPE	Jan 12	I-63	1.2.4. Modify
			1.4.2.2 Develop physical test procedure (MAC)

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Session	Date	Report	Content
64th GRPE	Jun 12	I-64	1.3.4. Develop test procedure
			1.5.1 Informal gtr I text
65th GRPE	Jan 13	I-65	1.1.6. Confirmation tests
			1.3.6.3. OCE testing
			1.4.2.3. Develop virtual test procedure (MAC)
66th GRPE	Jun 13	I-66	1.1.7. Round Robin tests
			1.1.6.4. Small modification to driving cycle
			1.3.7. Modify OCE
			1.4.2.5. Modify MAC
			1.5.2. Formal gtr I text
			1.6. Impact assessment
67th GRPE	Jan 14	I-67	
68th GRPE	Jun 14	II-68	2.1.1. Strategy and evaluation of existing regulation (OBD)
			2.4.0 Conformity strategy development and approval
69th GRPE	Jan15	II-69	2.4.2.1. Vehicle selection criteria
70th GRPE	Jun 15	II-70	2.1.2.3. Monitoring requirements
			2.2.3. Validation low ambient temperature
			2.3.3. Validation high altitude
			2.4.1.1. Whole vehicle durability
			2.4.1.2. Bench ageing tests

Deleted: 1.4.2.2. Develop physical test procedure¶

Deleted: 1.4.2.3. Develop virtual test procedure

Deleted: 1.5.1. Informal gtr I text

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Session	Date	Report	Content
			2.4.1.3. Develop test procedure
			2.4.2.2. In service testing
71st GRPE	Jan 16	II-71	2.1.2. Text development
72nd GRPE	Jun 16	II-72	2.4.2.3. Pass/fail judgement
74th GRPE	Jun 17	II-74	2.1.3. Validation OBD
75th GRPE	Jan 18	II-75	2.4.1. Durability
			2.4.2.4. Modify ISC
			2.6.1. Informal texts (emissions & OBD)
			2.6.3. Impact assessment
76th GRPE	Jun 18	II-76	2.6.2. Formal texts
78th GRPE	Jun 19	III-78	3.2. Correlation testing
79th GRPE	Jan 20	III-79	3.3.1. Initial gtr proposal
80th GRPE	Jun 20	III-80	3.3.2. Final gtr proposal
81st GRPE	Jan 21	III-81	3.4. Final gtr text
			3.5. Impact assessment

2. Milestones

Session	Date	Decision
57th GRPE	Jan 09	Start Roadmap
58th GRPE	Jun 09	Start WLTP Project
59th GRPE	Jan 10	Accept OCE strategy, allocate tasks accordingly and start development of candidate modes

Submitted by the WLTP Drafting Group	Working paper No. **WLTP-03-03** (3rd WLTP meeting, 10 June, 2009)

Session	**Date**	**Decision**
60th GRPE	Jun 10	Start evaluation of candidate modes, start test procedure
Interim IGM	Aug 10	Accept Initial data collection
61st GRPE	Jan 11	More data or progress with cycle development
Interim IGM	Apr 11	Accept initial cycle
62nd GRPE	Jun 11	Start OCE testing, start MAC virtual test procedure
Interim IGM	Oct 11	Start confirmation and Round Robin
64th GRPE	Jun 12	Include test procedure in gtr text, close DTP group unless low temperature and pressure is a DTP task, start MAC validation testing
66th GRPE	Jun 13	Close OCE group unless low temperature and pressure is an OCE task, Decide Phase II organisation
67th GRPE	Jan 14	Start phase II, close DNC group
68th GRPE	Jun 14	Close MAC group, decide conformity strategy
70th GRPE	Jun 15	Start durability validation
71st GRPE	Jan 16	Start ISC validation if new concept
74th GRPE	Jun 17	Close OBD group, start phase III
75th GRPE	Jan 18	Close conformity group
76th GRPE	Jun 18	Start correlation testing
78th GRPE	Jun 19	Start definition of emission limits and OBD thresholds
81st GRPE	Jan 21	Close WLTP Informal Group

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