UTAC CERAM

WLTP-13-06e


# WLTP RRT Status Report

## *11th of Jan – 12th of Jan 2016*

# Objectives

- Check the understanding and the application of the GTR15 (based on phase 1a text) in different labs

- Estimate the repeatability and reproducibility of the GTR15 test procedure in type approval conditions

# Schedule

- **End by Jan 2016 (still one "return lab" to go)**

- **Supplemental testing**
  - NEDC testing added by JRC but w/o interfering w/ the initial schedule (WLTP/NEDC correlation)
  - 2 labs were added: Horiba in April 2015 and TUEV Nord in July 2015

| Date | V1 | V2 | Golden Engineer |
|---|---|---|---|
| 22-24 Sept. 2014 | BMW | | Yes |
| 27-29 Oct. 2014 | FIAT | FIAT | Yes |
| 24-26 Nov. 2014 | UTAC | UTAC | Yes |
| 19-20 Jan. 2015 | PSA | PSA | Yes |
| 16-18 Feb 2015 | Daimler | Daimler | Yes |
| 16-18 March 2015 | Bosmal | Bosmal | Yes |
| April 2015 | Horiba | Horiba | JRC |
| 26-27 May 2015 | DEKRA | DEKRA | Yes |
| 22-23 June 2015 | VW | VW | Yes |
| 20-21 July 2015 | TÜEV Nord | TÜEV Nord | JRC |
| August 2015 | Bosmal | Bosmal | - |
| 14-15 Sept 2015 | JRC | JRC | Yes |
| Nov 2015 | BMW | BMW | - |
| Jan 2016 | | FIAT | ? |

# Test Equipment

- **Lab Equipment, were not strictly WLTP compliant. e.g.:**
  - Soaking areas, cannot always be set to 23°C because of other on going programs
  - RCB measurement equipment precision in GTR is very stringent, existing equipment is not yet always compliant, +Frequency
  - Dynosetting iterative method, test benches are not set to have the vehicle accelerated by its own power before dynosetting or have the rotating inertia taken into account
- **Input data**
  - Gear shift calculation => could not be checked during the RRT

  Due to improvements  of the tool since beginning of the RRT, labs have different versions + most labs have not developed their own calculation tool

# Test Results – Overview

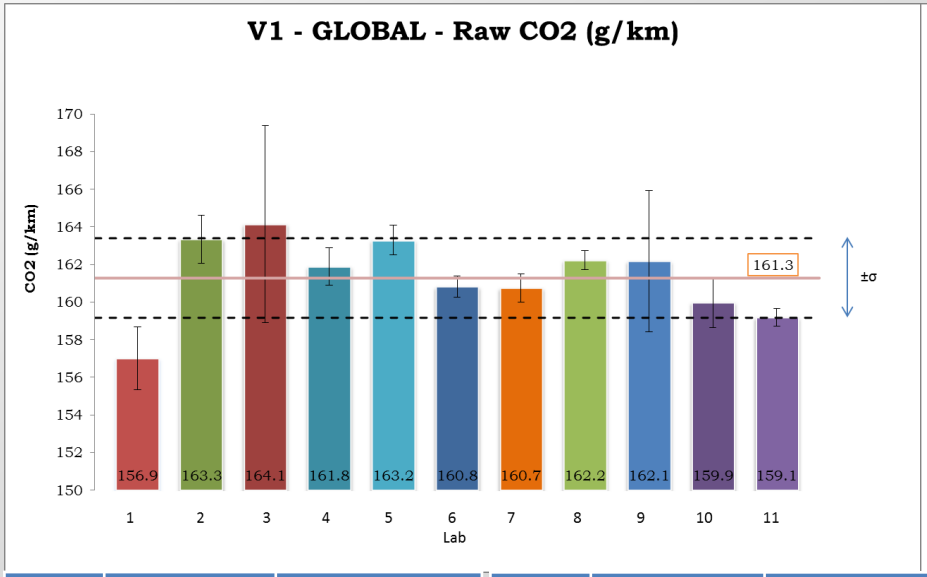
- **11 labs, 76 tests**
  - V1 (gasoline) : 11 test series
    - Minimum of 3 tests per lab => 43 tests
    - still 1 set to be handed in
  - V2 (diesel) : 9 test series
    - Minimum of 3 tests per lab => 33 tests
    - still 1 set to be handed in and 1 lab to go

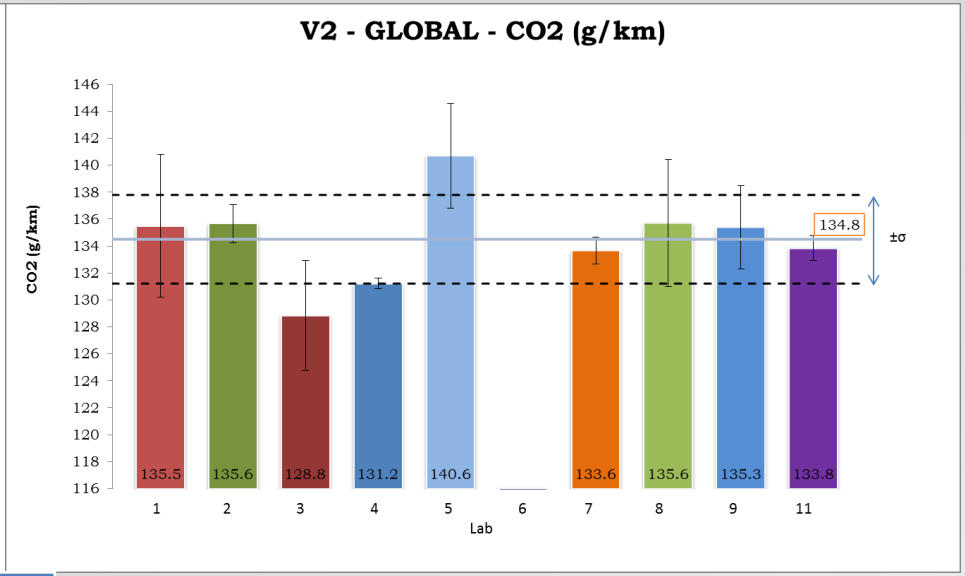
  ⇒ at this stage the results are **still temporary**, but nevertheless **representative**

- **Results have been statistically processed**
  - Calculation of the **uncertainty of the measurement in repeatability and reproducibility** conditions => for simplicity in this presentation only Standard deviation (σ) are presented (uncertainty being 2xσ)
  - Excluding **outliers** (reminder: labs can be considered as outliers, if their dispersion is too high or if their mean value is too biased)
    - Outliers are excluded from the final calculations to prevent "isolated effects" to interfere with the global result

- **The results can be found in annex of this presentation**
  - The results are not presented in chronological order

# Test Results - Focus on CO2



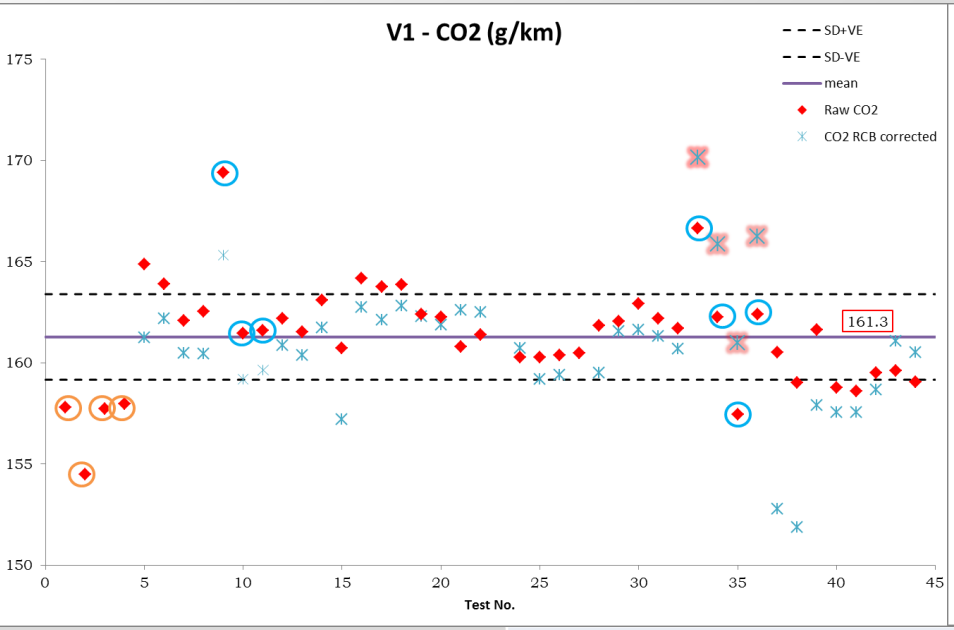



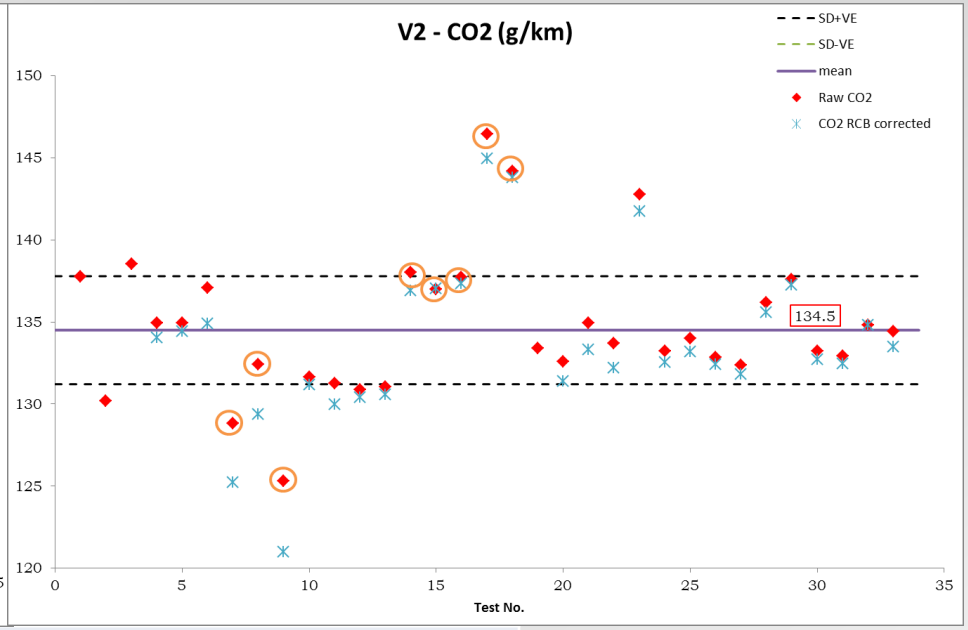

| All labs | WLTC | CO2 |
|---|---|---|
| V1 | **Mean** | **161.3** |
| | σRepeat | 1.9(1.2%) |
| | σRepro | 2.6(1.6%) |
| V2 | **Mean** | **134.8** |
| | σRepeat | 3.1(2.3%) |
| | σRepro | 4.3(3.2%) |

| w/o outliers | WLTC | CO2 |
|---|---|---|
| V1 | **Mean** | **161.5** |
| | σRepeat | 0.9(0.6%) |
| | σRepro | 1.7(1.1%) |
| V2 | **Mean** | **134.3** |
| | σRepeat | 2.6(2.0%) |
| | σRepro | 2.8(2.1%) |

- **Higher dispersion on V2 results**
  - Generally more difficult to carry out the dynosetting
- **As none of the tests require RCB correction according to GTR15**
  - for this program the mean value and the dispersion of the GTR15 procedure are equivalent to the raw CO2 results

# Test results – Focus on CO2




Highlighted in pink - correction as per regulation
circled orange ones – biased outliers / circled blue ones – dispersion outliers

- Dispersion can occur intra-lab (for V1 and V2)
- Biased results inter-lab (for V1 and V2)
- Usually when lab tests are biased from the other tests, dispersion is also high, but when a lab has small dispersion and is biased, then in "real life", the test would be validated (e.g. Lab 1 for V1)
- Only one series of tests is to be corrected to comply with GTR15 (validly of RCB measurement?) => not taken account in the final result

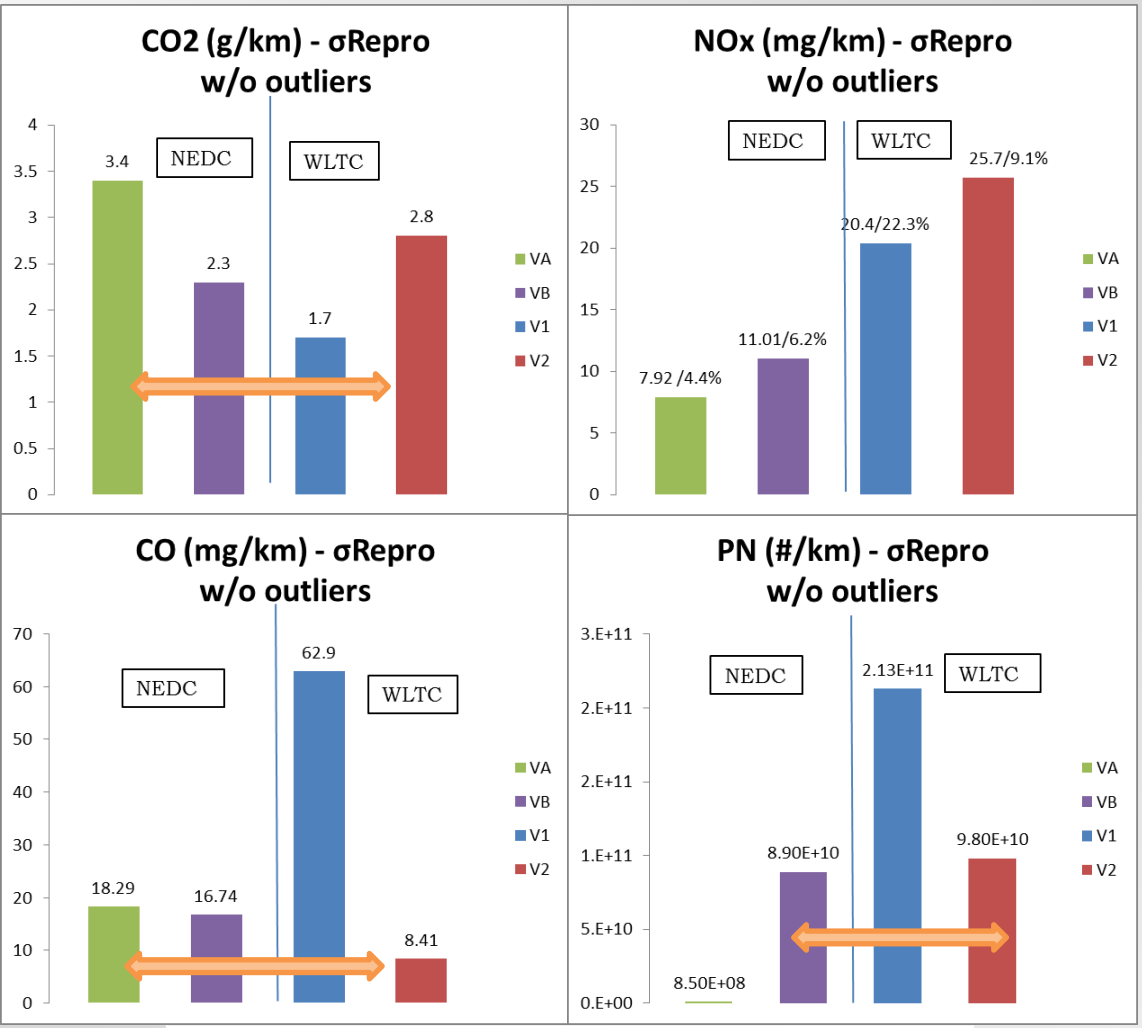
# Test Results – Focus on RCB correction

| | Including Outliers | | | w/o Outliers | | |
|---|---|---|---|---|---|---|
| | **Mean** | **σRepeat** | **σRepro** | **Mean** | **σRepeat** | **σRepro** |
| **Raw CO2 g/km** | | | | | | |
| **Vehicle 1** | 161.3 | 1.9(1.2%) | 2.6(1.6%) | 161.5 | 0.9(0.6%) | **1.7(1.1%)** |
| **Vehicle 2** | 134.8 | 3.1(2.3%) | 4.3(3.2%) | 134.3 | 2.6(2.0%) | **2.8(2.1%)** |
| **RCB corrected CO2 g/km** (all tests regardless of GTR15 criteria) | | | | | | |
| **Vehicle 1** | 160.5 | 1.9(1.2%) | 3.3(2.1%) | 160.5 | 1.3(0.9%) | **2.0(1.3%)** |
| **Vehicle 2** | 133.3 | 3.0(2.3%) | 4.9(3.7%) | 134.1 | 2.8(2.2%) | **4.1(3.1%)** |

RCB correction would tend to increase the dispersion of the results.

- Discrepancies between the RCB measurement (not all comply with GTR15: frequency, equipment)
- Question had been raised from labs if requirements in GTR15 for RCB measurement are cost-efficient => yes

# Test results – Comparison w/ R83




Vehicle 1 - Gasoline & Vehicle 2, A & B - Diesel

- Comparison with ACEA PN RRT program (2009)
- The uncertainties of both procedures are equivalent apart from the NOx for which there is an increase in absolute value, less in
  - To define whether it is due to vehicle or procedure => JRC NEDC program

# Test results – Comparison w/ Asian RRT

| | EU RRT V1 (Petrol) – all labs | | Asian RRT V1 (Petrol) | |
|---|---|---|---|---|
| | Mean | σRepro | Mean | σ All |
| CO2 [g/km] | 161 | 2.6 (1.6%) | 162 | 2.2 (1.3%) |
| NOx [mg/km] | 95 | 27 (29%) | 12 | 4 (33%) |
| CO [mg/km] | 456 | 68 (15%) | 334 | 57 (17%) |
| HCT[mg/km] | 41 | 9 (23%) | 29 | 6 (19%) |

- EU data come from the raw database (including outliers), as to be comparable with the Asian RRT
- Similar results from both RRT for the petrol vehicles

# Dispersion improvement

- See complementary file (excel) for comments on all the GTR items
- Most efficient way: **have the equipment compliant with the GTR15**
  - Especially the dynosetting softwares (verification of the 10N, rotating inertia, precon etc)
- **Improve clarity of text**
  - Only the rotating inertia issue was identified during the program and already solved
- **Improve the RCB monitoring**
  - Text is already clear, labs need more training?
  - Adapt equipment and frequency of monitoring
- **Gear shift**
  - Check the use of the tool and the comprehension of the text

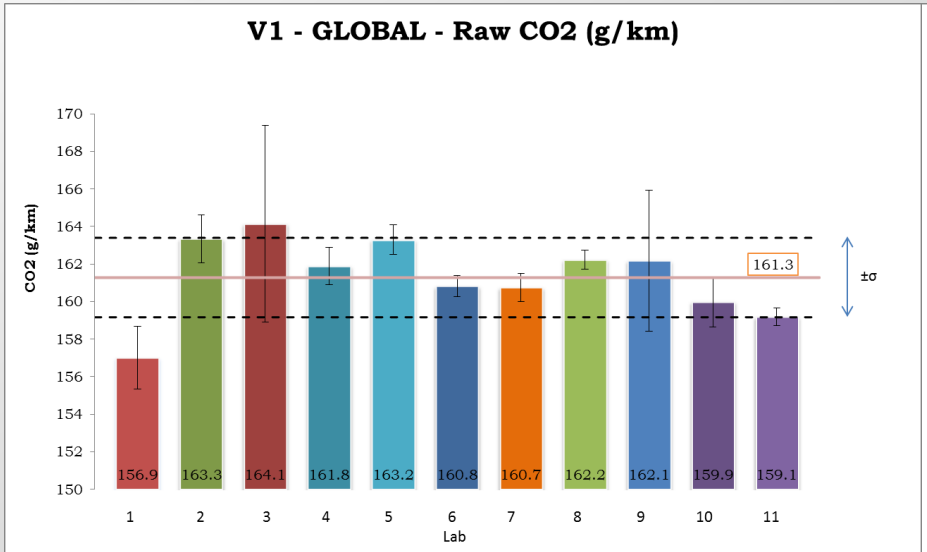
# Thank you for attention

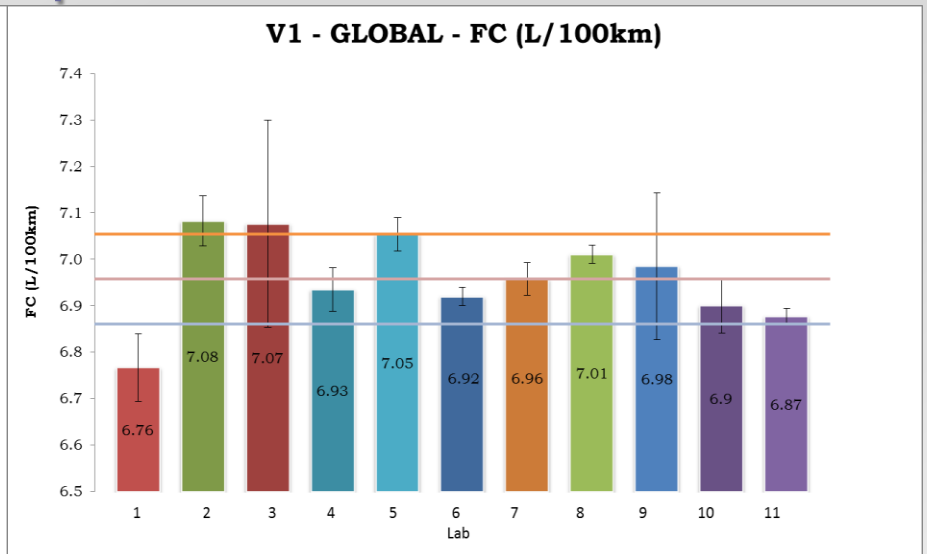
# Test Results

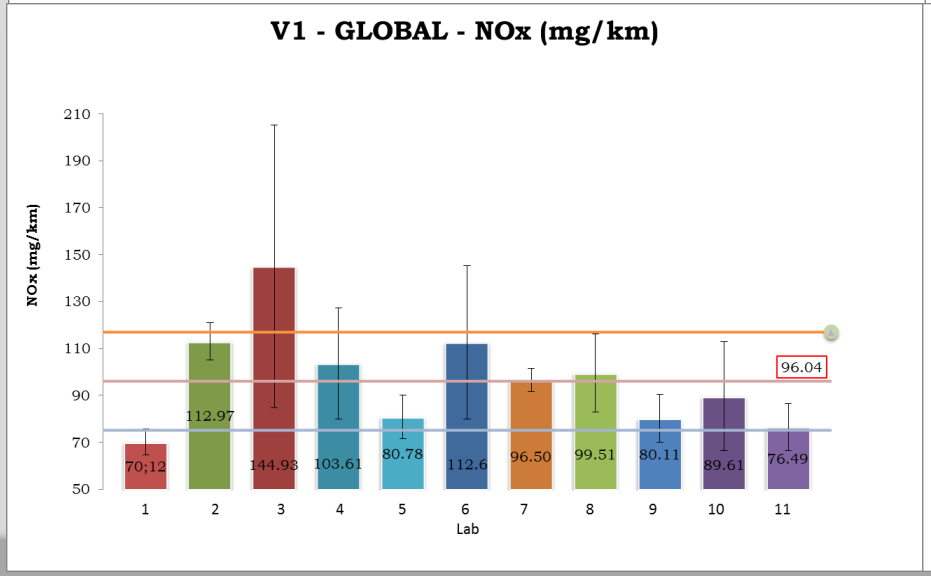
| All labs | WLTC | CO2 | CO2 corr | FC | NOx | CO | HCT | PN | PM |
|---|---|---|---|---|---|---|---|---|---|
| V1 | **Mean** | **161.3** | **161.5** | **6.96** | **95.17** | **456.25** | **40.60** | **3.36E+12** | **3.94** |
| | σRepeat | 1.9(1.2%) | 1.7(1.1%) | 0.08(1.1%) | 20.32(21.4%) | 54.13(11.9%) | 6.43(15.8%) | 2.2E+11(6.6%) | 0.80(20.3%) |
| | σRepro | 2.6(1.6%) | 2.7(1.7%) | 0.11(1.7%) | 27.17(28.6%) | 67.94(14.9%) | 9.14(22.5%) | 2.9E+11(8.5%) | 1.48(37.7%) |
| V2 | **Mean** | **134.8** | **134.8** | **5.13** | **291.45** | **39.31** | **7.96** | **5.00E+11** | **0.23** |
| | σRepeat | 3.1(2.3%) | 3.1(2.3%) | 0.11(2.3%) | 26.50(9.1%) | 4.81(12.3%) | 2.20(27.8%) | 1.0E+11(20.1%) | 0.10(46.6%) |
| | σRepro | 4.3(3.2%) | 4.2(3.2%) | 0.18(3.5%) | 35.72(12.3%) | 15.42(39.2%) | 3.67(46.2%) | 1.3E+11(25.4%) | 0.16(69.2%) |

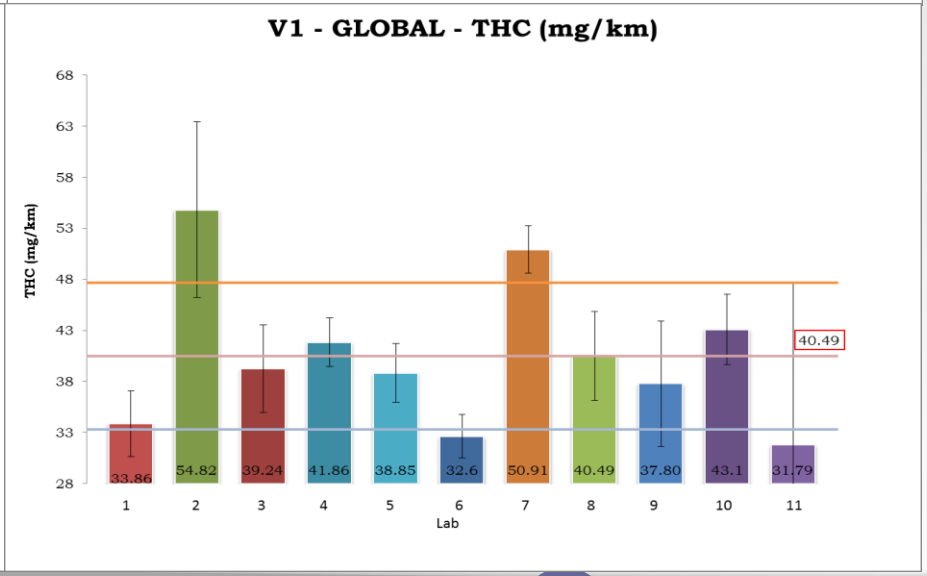
| w/o outliers | WLTC | CO2 | CO2 corr | FC | NOx | CO | HCT | PN | PM |
|---|---|---|---|---|---|---|---|---|---|
| V1 | **Mean** | **161.5** | **160.5** | **6.97** | **91.44** | **5.49** | **39.98** | **3.42E+12** | **3.84** |
| | σRepeat | 0.9(0.6%) | 1.3(0.9%) | 0.04(0.6%) | 16.01(17.5%) | 0.39(7.2%) | 3.62(9.1%) | 1.5E+11(4.4%) | 0.35(9.3%) |
| | σRepro | 1.7(1.1%) | 2.0(1.3%) | 0.08(1.2%) | 20.40(22.3%) | 0.62(11.3%) | 6.33(15.8%) | 2.1E+11(6.2%) | 0.72(18.9%) |
| V2 | **Mean** | **134.3** | **134.1** | **5.07** | **281.74** | **3.11** | **7.90** | **5.23E+11** | **0.21** |
| | σRepeat | 2.6(2.0%) | 2.8(2.2%) | 0.10(2.1%) | 21.51(7.6%) | 1.59(51.3%) | 1.78(22.6%) | 7.4E+10(14.2%) | 0.07(35.1%) |
| | σRepro | 2.8(2.1%) | 4.1(3.1%) | 0.13(2.5%) | 25.74(9.1%) | 2.05(66.0%) | 2.32(29.4%) | 9.8E+10(18.7%) | 0.11(57.1%) |

# Tests Results – Graphs – V1



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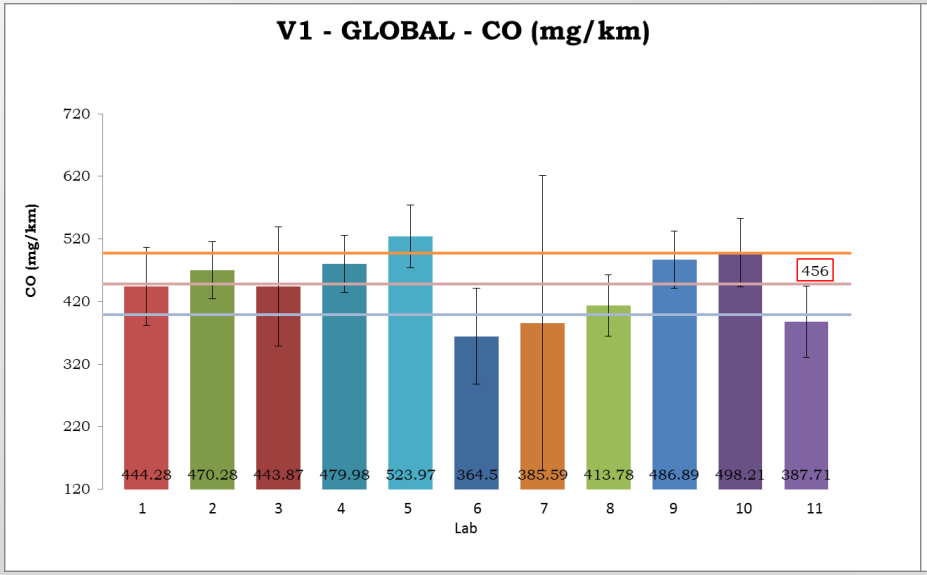
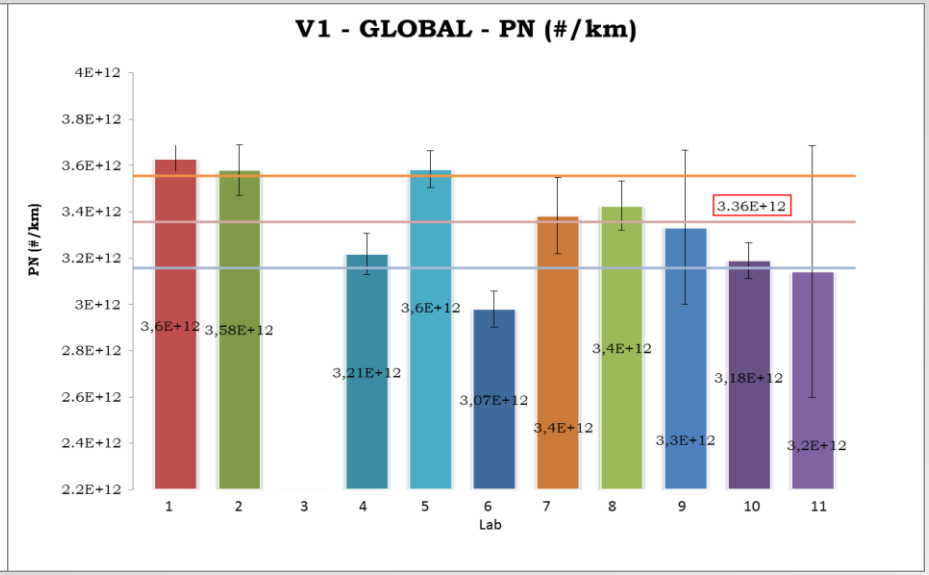
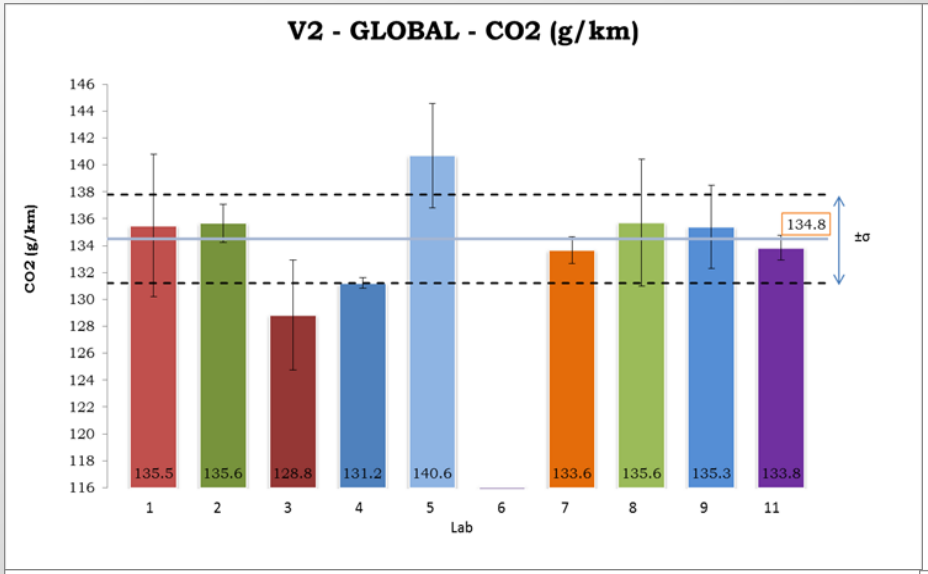
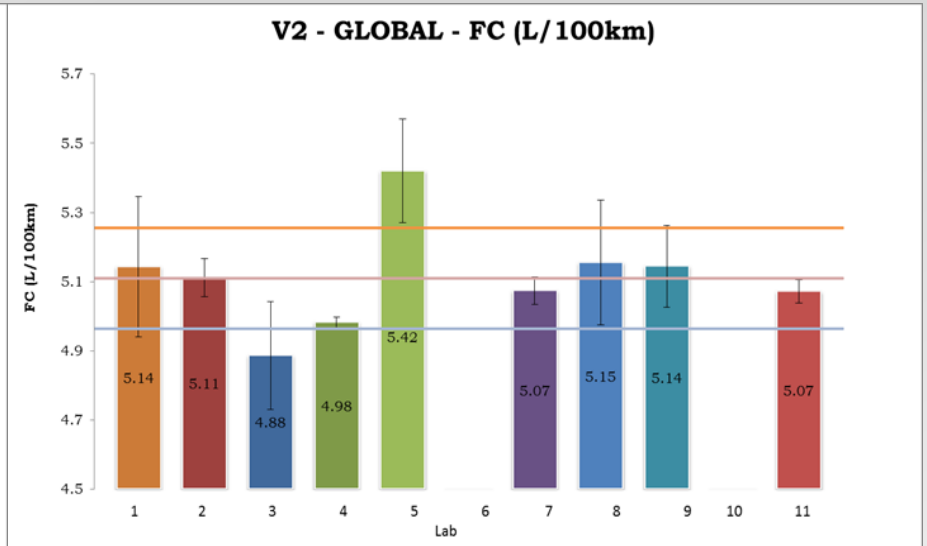
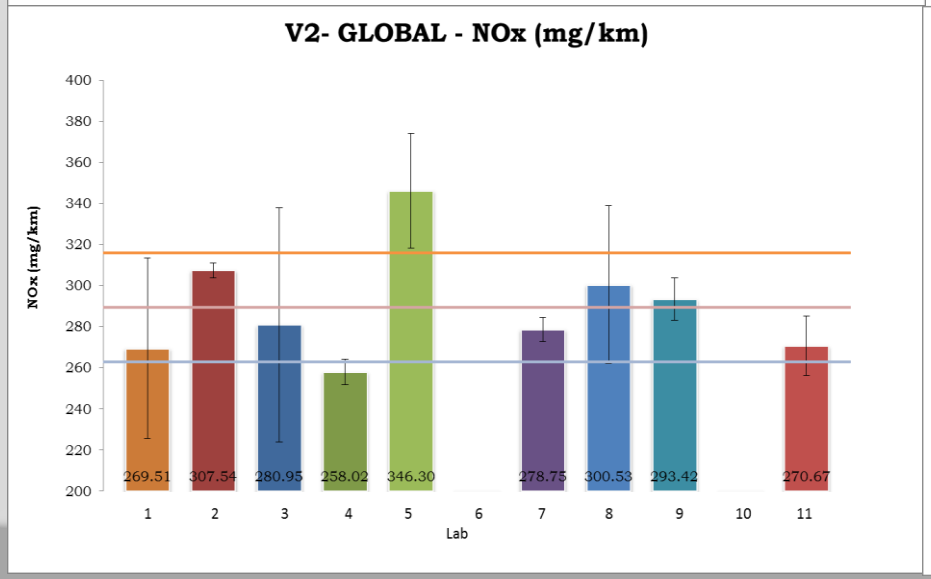


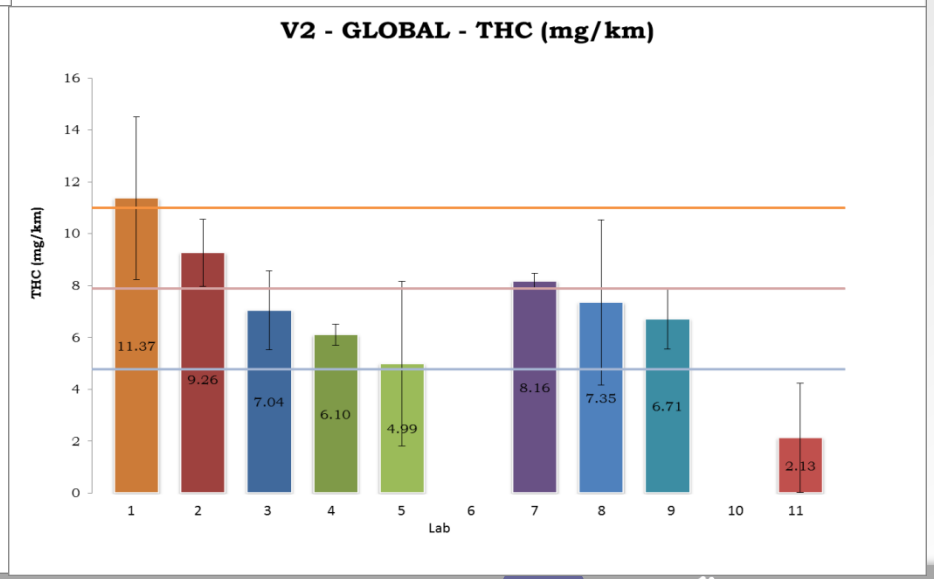



# Tests Results – Graphs – V2



# Tests Results – Graphs – V2