厦门在用车排放测试
项目介绍
Xiamen In-use Vehicle Emission Test Project Presentation

Xiamen Environment Protection Vehicle Emission Control Technology Center

厦门环境保护机动车污染控制技术中心

Contents

Project Background

- **Objective**
- **Test procedure**
- **Project time**

Background

- **Objective**
  - Measure light-duty vehicles fuel consumption and emissions in different testing cycles with laboratory chassis dyno tests devices.
  - Compare the emission intensity of light-duty vehicles in China and European countries.
  - Provide supports to China Vehicle Emission Model
- **Test procedure**
  - GB18352.3_2005 , Limits and measurement methods for emissions from light-duty vehicles (III,IV)
  - GB18352.5_2013 , Limits and measurement methods for emissions from light-duty vehicles (V)
  - Test proposal from GIZ (TOR).
- **Project time**
  - 2015/10/14 to 2015/11/21 : Test preparation, including vehicle renting , test proposal determination, test hardware/software preparation.
  - 2015/11/22 to 2015/11/29 : Complete first vehicle test (VW golf).
  - 2015/11/30 to 2015/12/21 : Golf test result analysis and the other five vehicles renting.
  - 2015/12/22 to 2015/12/31 : Complete five gasoline vehicles test.
  - 2016/1/1 to now : Results analysis.

Test Preparation

- **Vehicle selection**
- **Test fuel**

➢ Vehicle selection

- **Original target Vehicle**

Vehicle class	ERMES lab	EURO class	Vehicle Make	Vehicle Model	Technology/Fuel	Engine capacity [l]	veh_ccm	registration year	Available Cycles				
									Legisl.	CADC	ERMES	HBEFA/EMPA	TUG
pass. car	EMPA	EURO-3	HONDA	ACCORD 2.0I VTEC	petrol	1,4-<2L	1,997	2000	yes	yes	no	yes	no
pass. car	EMPA	EURO-3	FORD	MONDEO 2.0	petrol	1,4-<2L	1,999	2001	yes	yes	no	yes	no
pass. car	TUG	EURO-4	Volkswagen	VW Golf V 1.4 MPI	petrol	<1,4L	1,390	2008	yes	yes	no	yes	yes
pass. car	TUG	EURO-4	TOYOTA	TOYOTA YARIS 5-TÜRIG 1.0 VVTI	petrol	<1,4L	998	2003	yes	yes	no	no	no
pass. car	TUG	EURO-5	VW	Golf VI	petrol	<1,4L	1,390	2011	yes	no	yes	no	no
pass. car	EMPA	EURO-5	Mazda	3 2.0 DI	petrol	>=2L	1,999	2010	yes	yes	no	yes	no

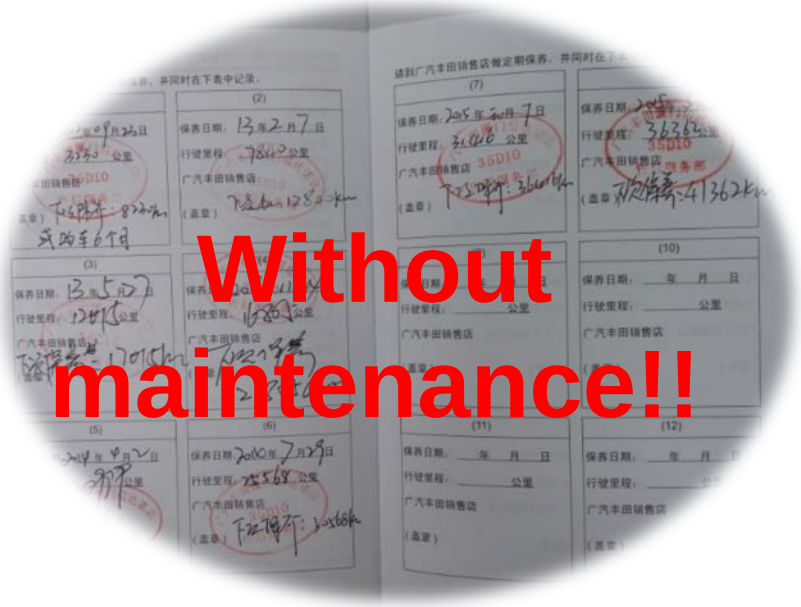
- **Problem occurred during vehicle selection**

  - Some vehicles were difficult to find in China due to differences between china-euro market. For example:

- No Golf(V) 1.4 PFI in Chinese market , only Golf(V) 1.4T GDI.
- No Yaris 1.0L , only Yaris 1.3L and 1.5L exist.
- Most of the vehicles on renting market are Euro IV / AT ones, Euro III/ V MT vehicles are rare.

- Vehicles may exist the following problem on Chinese market:

- Vehicle didn’t not be maintained according to the requirement of manufacture.
- Some Vehicles didn’t be handled in time when MIL illuminated.



- **Requirement for vehicle selection**

Choose similar vehicles tested in euro as same as possible, including the following aspects.

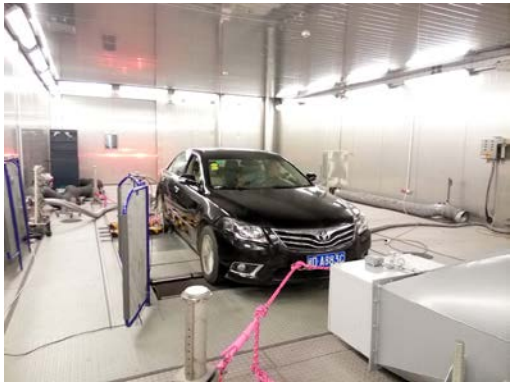
- Vehicle model
- Engine displacement
- Fuel injection technology
- Emission standard

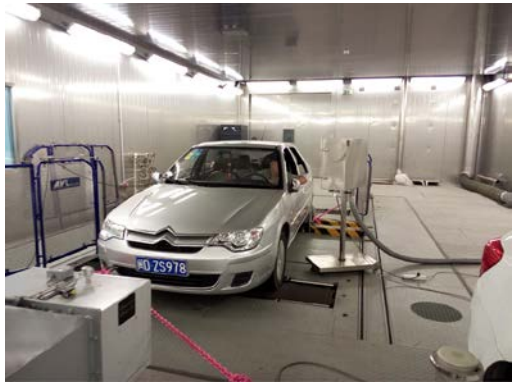
Vehicle should be further determinated by GIZ prior to test starting!

- **Final vehicle selection**

- Honda Accord (2.0 MT ,PFI , Euro III) was exactly the same as vehicle tested at EMPA.

- The other five vehicles were changed to be the popular ones on china market and take engine capacity, emission standard and fuel injection technology into consideration.





- **vehicle list**

Brand-Model	Disp（L）	Trans	Emis Std	Inj Type	Engine type	Year	Mileage (km)	Curb mass (kg)	Max mass (kg)
Honda-Accord	2.0	MT	Euro III	PFI	1AZ	2007	129,997	1421	1870
VW-Jetta	1.6	MT	Euro IV	PFI	EA113	2010	28,915	1091	1545
VW-Golf	1.4	AT	Euro IV	GDI	CFB	2012	48,619	1370	1800
Citroen-Elysee	1.6	MT	Euro IV	PFI	N6A 10FX3A PSA	2012	98,941	1150	1580
Chevrolet-Cruze	1.5	AT	Euro V	PFI	L2B	2015	20,326	1260	1778
Toyota-Camry	2.0	AT	Euro V	PFI	6AR-FSE	2015	25,882	1520	2000

➢ Test Fuel

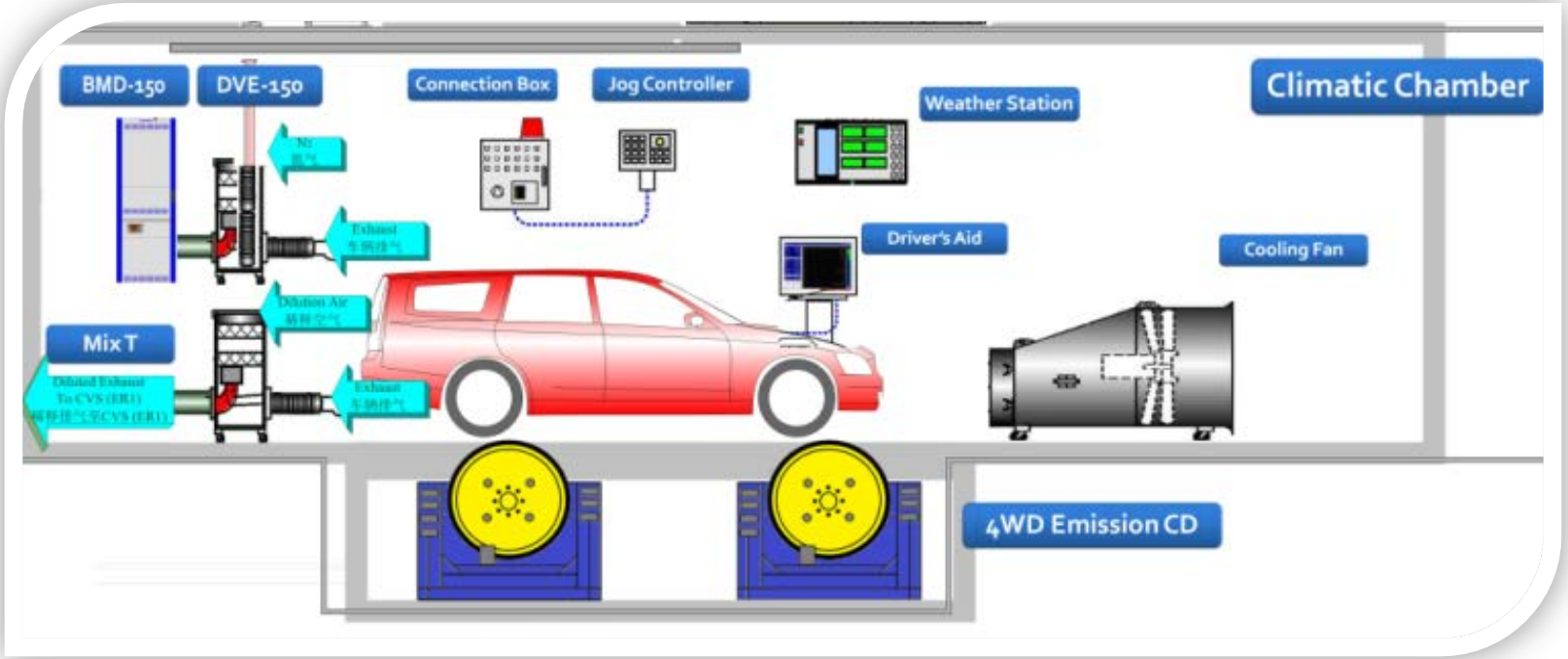
Reference fuel was used for tests.

Reference Fuel Specifications				
Item	Method	Result		
		China IV	China V	Unit
Density (at 15° C)	ASTM D4052-11	0.7547	0.7387	[g/cm^3]
C-content	M 1394	86.73	86.55	[%mass]
H-content		13.27	13.45	[%mass]
O-content		<0.01	<0.01	[%mass]
S-content	ASTM D5453-12	30	<1	[mg/kg]
Octane number	ASTM D2699-13b/ASTM D2700-14	91	92	[Rating]
lower heating value	M 2521	43.16	43.29	[MJ/kg]
Vapour Pressure(DVPE)	ASTM D5191-13	58.2	61.7	[kPa]
Olefins	GC	9.5	9	[%(V/V)]
Aromatics		33.3	33.8	[%(V/V)]
T_{50}	ASTM D86-12	na	100.6	[°C]
T_{90}		na	150.5	[°C]
Ethanol Content	ASTM D4815-15	<0.01	<0.01	[%mass]

Test Process

- Test equipment
- Test control
- Test cycle
- Vehicle check
- Test sequence

➢ Test Equipment



System configurations

- System detailed configuration
  - AVL 48'' 4WD Emission CD
  - AVL LE GASOLINE/DIESEL EMISSION TEST SYSTEM

    With AMA i60 / CVS i60 / PSS i60 / BMD&DVE 150
  - Imtech Environmental simulation system for vehicle emission test
  - TSI Particle counting system

- Applying Heated-CVS and BMD/DVE technology to the requirements for China 5 and super low emission vehicles.

VTC 1

➢ Test Control

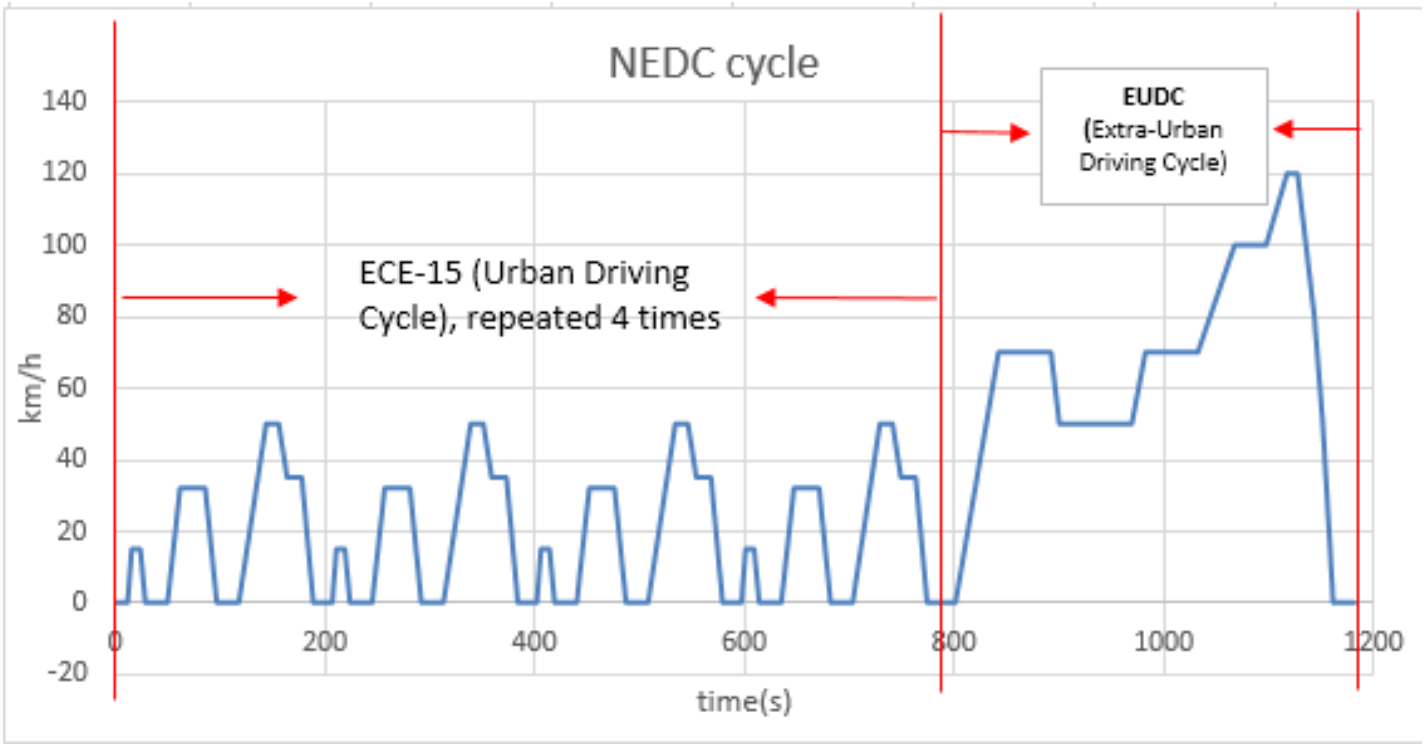
- All the tests were conducted in the same test cell with the same driver to keep good test repeatability.
- In order to reappear the resistance and inertia setting as in Europe, GIZ provided vehicle road load target value and inertia to VETC before the tests.
- NEDC and CADC test cycle were performed for each vehicle at least two times. And repeat tests were undertaken where necessary

➢ Test Cycle

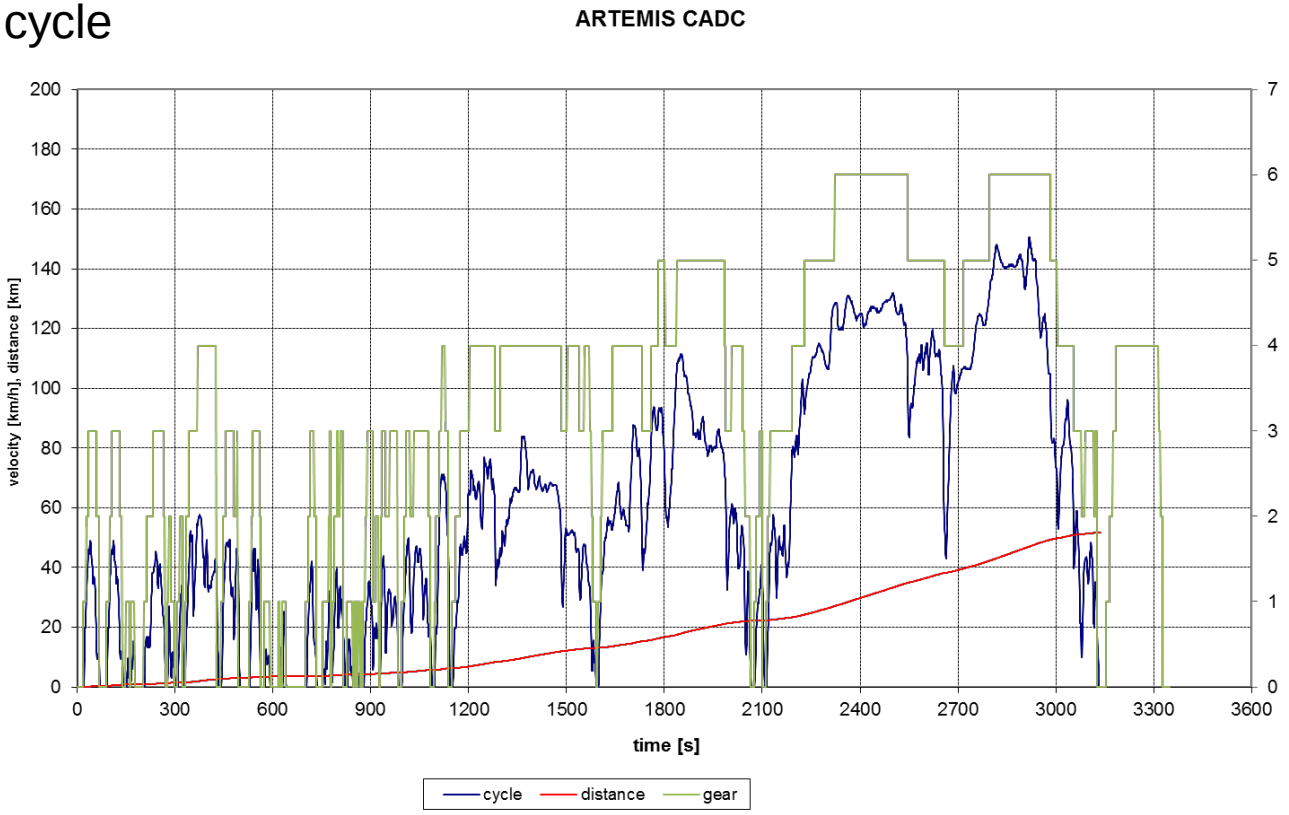
Following test cycles are typically used in tests for emission factors from passenger cars and LCV in the ERMES group.

Test cycle	Hot/ cold	Pre-conditioning cycle	Temp setting	Test procedure	Remarks
NEDC	cold	NEDC	-		
IUFC	cold	IUFC	-		
ERMES	hot	5min@100km/h	-		
	cold		-7°C, 0°C, 10°C, 23°C	-	option
CADC	hot	5min@100km/h	-		
	cold		-7°C, 0°C, 10°C, 23°C	-	option

- NEDC cycle


NEDC cycle
EUDC
(Extra-Urban
Driving Cycle)
ECE-15 (Urban Driving
Cycle), repeated 4 times
km/h
140
120
100
80
60
40
20
0
-20
0
200
400
600
800
1000
1200
time(s)

- CADC cycle



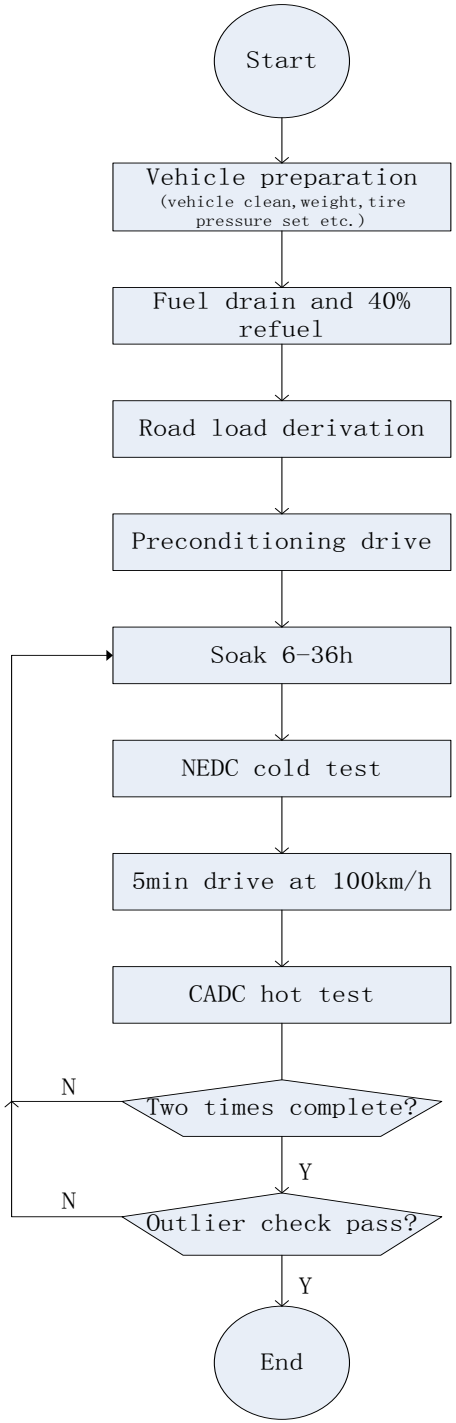
Gear strategy for MT Vehicle						
Brand-Model	$V(3)_{1000}$ (km/h)	Speed_rated (rpm)	V(3)p(km/h) meas	V(3)p(km/h) Calc	MP (W/Kg)	gear strategy
Honda-Accord	24.9	6000	136	149	77	1
VW-Jetta	20.7	5600	114	116	64	3
Citroen-Elysee	18.9	6000	112	113	75	3

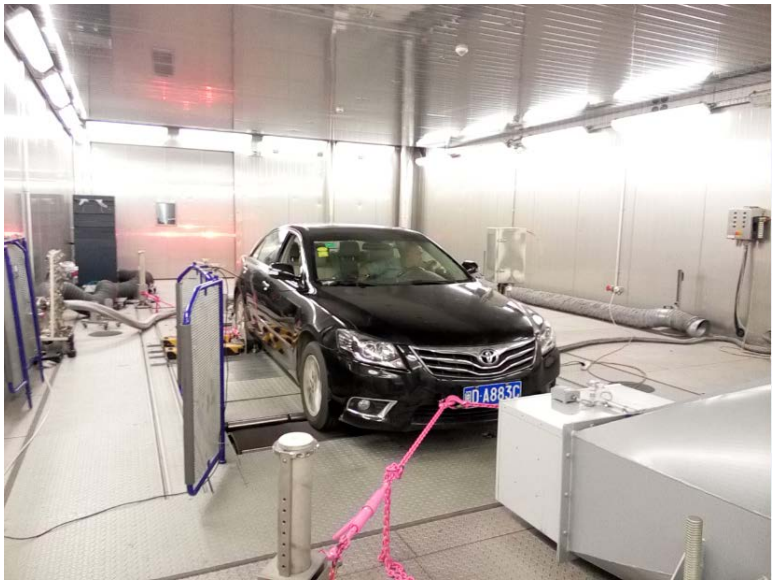
➢ Vehicle check

- Configuration information check for test vehicle.
- Air induction system check
- Exhaust system check (O_2 sensor, TWC and leakage)

Vehicle was in good mechanical conditions and without obvious malfunctions.

➢ Test sequence





At least two tests conducted and repeat tests were undertaken where necessary!

Test Results & Analysis

- Test results overview
- Rejection of the test results
- Test repeatability check
- In-use conformity check
- Phase emission compare

➢ Test results overview

Test Results_GIZ												
Date	Test NO.	Vehicle	Test Cycle	CO (g/km)	CO2 (g/km)	THC (g/km)	CH4 (g/km)	NOx (g/km)	FE (L/100km)	PM (g/km)	PN (#/km)	Remarks
2015/11/24	1	Golf	NEDC	0.452	145.33	0.037	0.005	0.011	6.10	0.0090	-	CPC crash
			CADC	1.431	150.29	0.035	0.010	0.034	6.37	0.0030	-	
2015/11/25	2		NEDC	0.373	153.37	0.039	0.005	0.01	6.43	0.0010	1.05E+12	
			CADC	1.306	150.12	0.026	0.007	0.025	6.36	0.0020	9.38E+11	
2015/11/26	3		NEDC	0.245	148.48	0.027	0.004	0.011	6.22	-	1.91E+12	PSS i60 error
			CADC	1.567	150.13	0.029	0.008	0.03	6.37	0.0030	1.48E+12	
2015/11/27	4		NEDC	0.238	149.22	0.029	0.004	0.014	6.25	-	1.74E+12	PSS i60 error
			CADC	1.286	150.64	0.023	0.006	0.027	6.38	0.0030	1.28E+12	
2015/12/24	1	Accord	NEDC	0.564	191.13	0.123	0.021	0.056	8.03	0.0030	2.45E+11	
			CADC	1.611	189.50	0.051	0.027	0.010	8.03	0.0130	1.20E+12	
2015/12/25	2		NEDC	0.826	192.23	0.145	0.022	0.051	8.10	0.0003	2.66E+11	driver error at the beginning of 4th ece15
			CADC	1.077	191.05	0.044	0.025	0.011	8.05	0.0080	7.24E+11	
2015/12/26	3		NEDC	0.653	192.16	0.133	0.022	0.046	8.08	0.0002	1.81E+11	
			CADC	1.869	189.06	0.053	0.027	0.008	8.02	0.0046	7.24E+11	
2015/12/27	4		NEDC	0.68	194.97	0.139	0.023	0.053	8.20	0.0002	2.51E+11	
			CADC	1.609	189.18	0.048	0.026	0.009	8.01	0.0049	6.73E+11	
2015/12/25	1	Elysee	NEDC	2.466	169.24	0.180	0.021	0.724	7.25	0.0004	5.82E+11	250s engine speed signal missing after test start
			CADC	6.912	167.34	0.137	0.039	1.589	7.46	0.0116	2.47E+12	
2015/12/26	2		NEDC	2.923	170.32	0.177	0.021	0.88	7.33	0.0002	5.15E+11	
			CADC	5.519	167.32	0.119	0.036	1.68	7.36	0.0060	2.05E+12	
2015/12/27	3		NEDC	2.849	170.26	0.169	0.021	0.931	7.32	0.0002	5.37E+11	
			CADC	5.216	166.74	0.123	0.036	1.709	7.32	0.0063	2.55E+12	

➢ Test results overview

Test Results_GIZ												
Date	Test NO.	Vehicle	Test Cycle	CO (g/km)	CO2 (g/km)	THC (g/km)	CH4 (g/km)	NOx (g/km)	FE (L/100km)	PM (g/km)	PN (#/km)	Remarks
2015/12/25	1	Cruze	NEDC	0.562	159.81	0.040	0.004	0.022	6.86	0.0002	9.99E+10	
			CADC	2.914	149.04	0.011	0.005	0.009	6.55	0.0020	1.75E+11	
2015/12/26	2		NEDC	0.544	158.87	0.040	0.003	0.015	6.82	0.0002	1.04E+11	
			CADC	3.088	150.68	0.007	0.004	0.005	6.63	0.0013	1.89E+11	
2015/12/27	3		NEDC	0.478	159.13	0.037	0.003	0.016	6.82	0.0002	1.43E+11	
			CADC	2.947	151.36	0.006	0.003	0.004	6.65	0.0011	1.59E+11	
2015/12/25	1	Camry	NEDC	0.499	206.86	0.063	0.005	0.015	8.86	0.0003	-	primary dilutor error
			CADC	no test performed,pn counter primary dilutor error fixing								
2015/12/26	2		NEDC	0.377	206.58	0.054	0.004	0.016	8.84	0.0002	2.15E+11	
			CADC	0.831	189.21	0.004	0.001	0.01	8.13	0.0050	2.18E+11	
2015/12/27	3		NEDC	0.481	207.74	0.055	0.004	0.015	8.90	0.0003	3.08E+11	
			CADC	0.627	188.67	0.003	0.001	0.009	8.09	0.0028	1.47E+11	
2015/12/29	1	Jetta	NEDC	0.874	181.50	0.076	0.012	0.041	7.64	0.0005	9.45E+10	
			CADC	0.495	172.07	0.040	0.015	0.034	7.22	0.0118	3.41E+11	
2015/12/30	2		NEDC	0.802	181.74	0.073	0.012	0.034	7.65	0.0006	1.62E+11	
			CADC	0.618	174.00	0.035	0.013	0.017	7.31	0.0066	2.44E+11	
2015/12/31	3		NEDC	0.873	178.30	0.09	0.013	0.034	7.51	0.0005	1.70E+11	
			CADC	0.523	172.10	0.031	0.011	0.018	7.22	0.0051	2.29E+11	

➢ Rejection of the test results

Results only rejected when

- Engineering reason
  - — Engine or test equipment malfunction
  - — Driver errors
  - — Any deviations from the procedure
- Strong statistical evidence of an outlier

Can’t ignore results just because we don’t like the answer!

➢ Repeatability Check

OUTPUT

Outlier Check (for 4 Samples)

CO (g/km)	Result	T Statistic	p value* 0.05	0.10
1st Obs	0.5640	(1.0733)		
2nd Obs	0.8260	1.3353	O	
3rd Obs	0.6530	(0.2551)	Ok	
4th Obs	0.6800	(0.0069)	Ok	
Mean =	0.6808			
Stdev =	0.1088			

Outlier Check (for 4 Samples)

FE (L/100km)	Result	T Statistic	p value* 0.05	0.10

Outlier Check (for 4 Samples)

THC (g/km)	Result	T Statistic	p value* 0.05	0.10
bs	0.1230	(1.2792)	Ok	Ok
	0.1450	1.0660	Ok	Ok
	0.1330	(0.2132)	Ok	Ok
	0.1390	0.4264	Ok	Ok
	0.1350			
	0.0094			

NOx(g/km)	Result	T Statistic	p valu 0.05	
1st Obs	0.0560	1.0706	Ok	
2nd Obs	0.0510	(0.1190)	Ok	Ok
3rd Obs	0.0460	(1.3085)	Ok	Ok
4th Obs	0.0530	0.3569	Ok	Ok
Mean =	0.0515			
Stdev =	0.0042			

2nd Obs	0.0003	(0.5442)	Ok	Ok
3rd Obs	0.0002	(0.6099)	Ok	Ok
4th Obs	0.0002			
Mean =	0.0012			
Stdev =	0.0016			

)	Result	T Statistic	p value* 0.05	0.10
s	2.45E+11	0.3241	Ok	Ok
2nd Obs	2.66E+11	0.7978	Ok	Ok
3rd Obs	1.81E+11	(1.1218)	Ok	Ok
4th Obs	2.51E+11			
Mean =	2.31E+11			
Stdev =	4.41E+10			

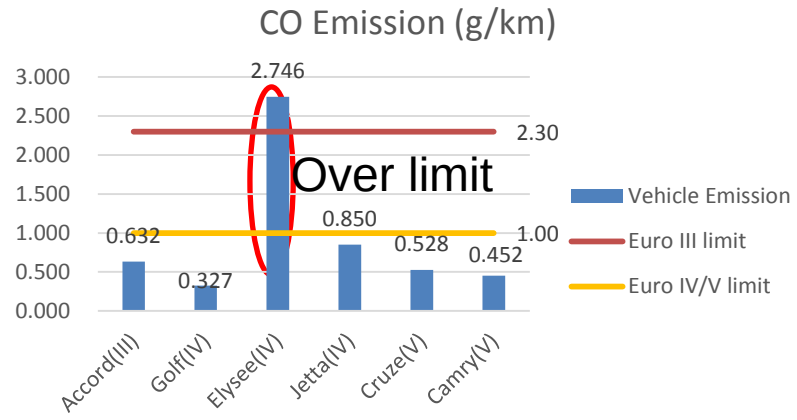
Using ASTM-E178 as a tool to determine test repeatability

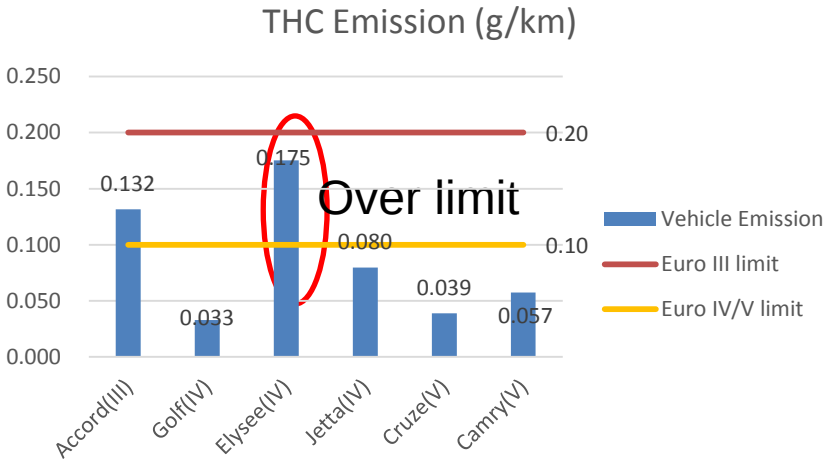
Results show good test repeatability for each vehicle!

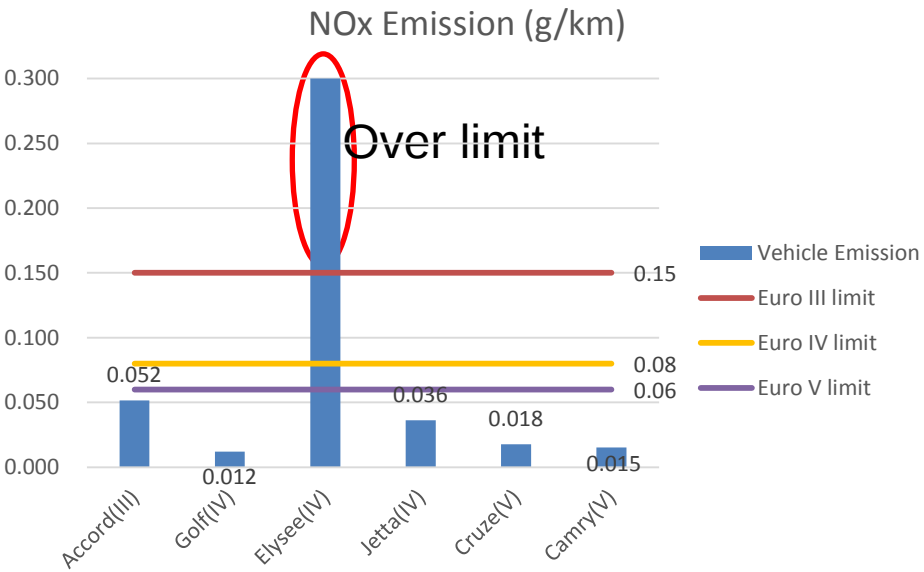
ASTM-E178 Standard Practice for Dealing With Outlying Observations

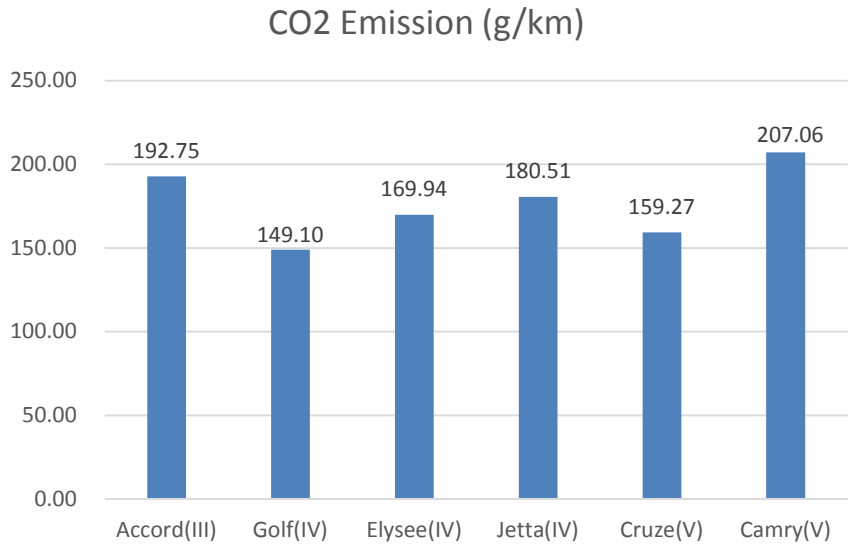
➢ In-use conformity check

- Gaseous emission

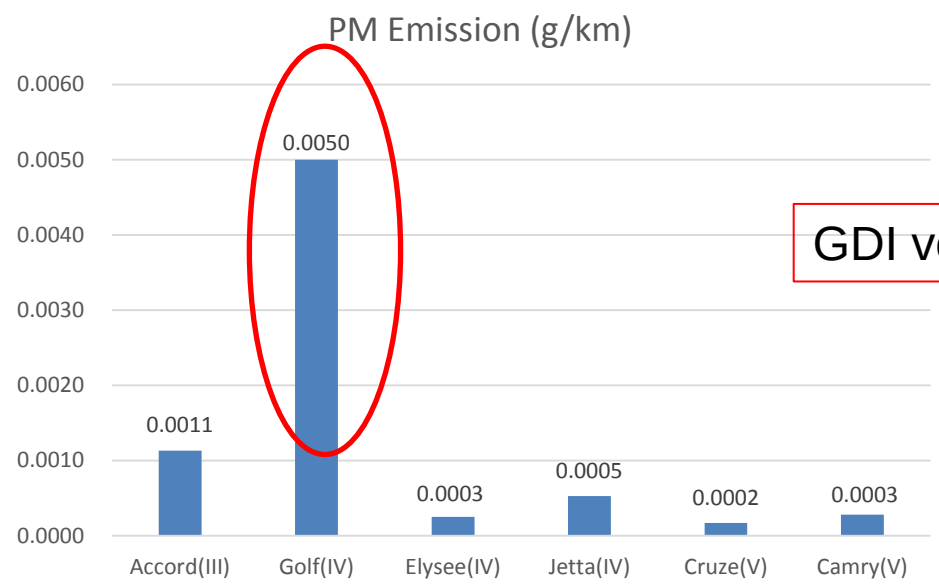




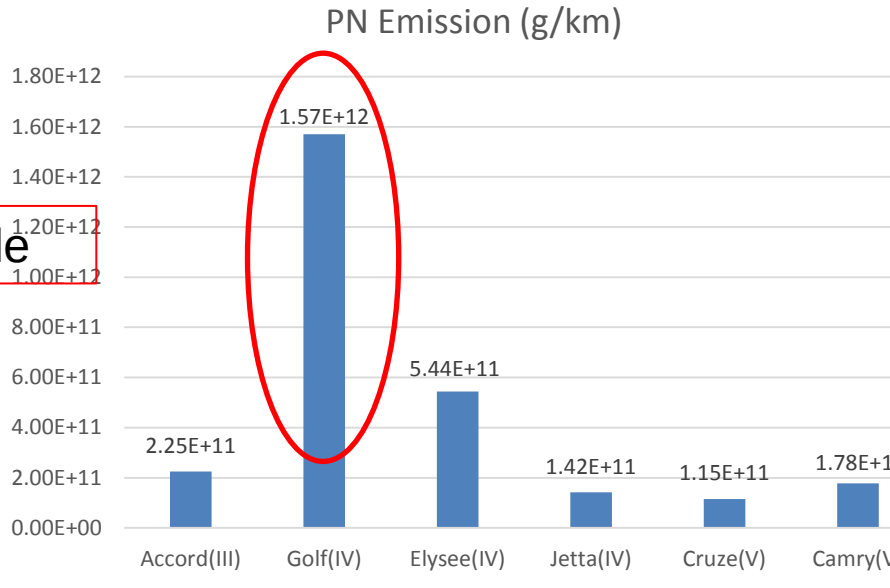




- Particle emission



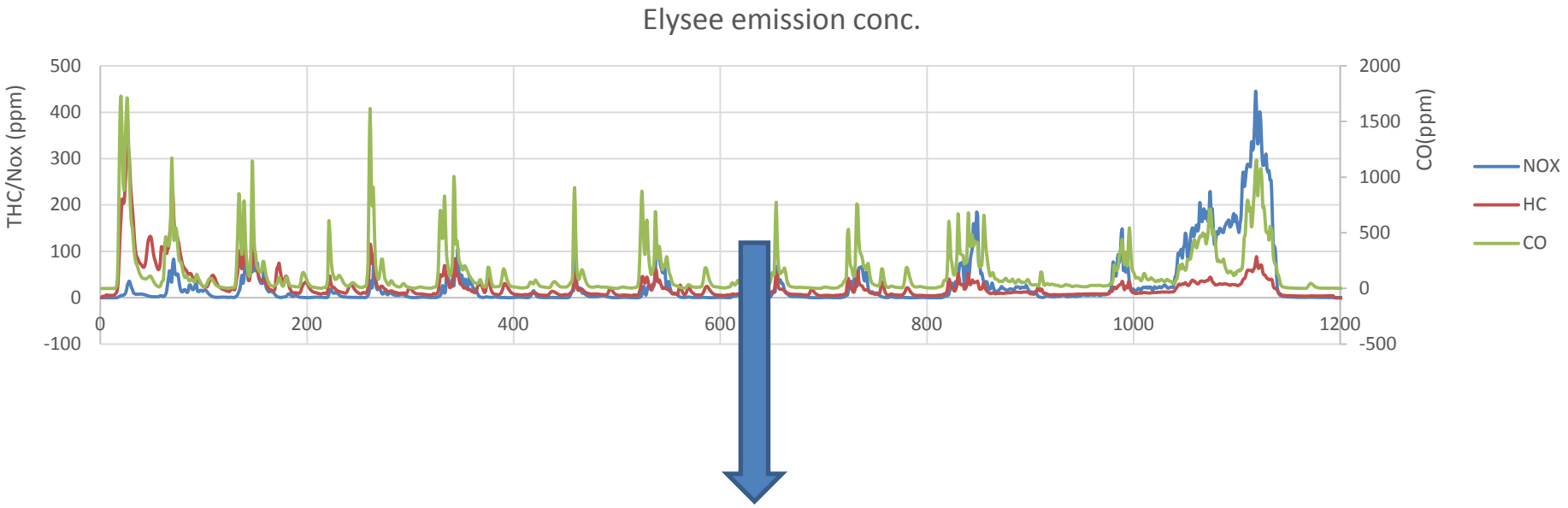
GDI vehicle



— No particle emission requirement in stage III and IV for gasoline vehicle.

— No particle emission requirement in V for PFI vehicle.

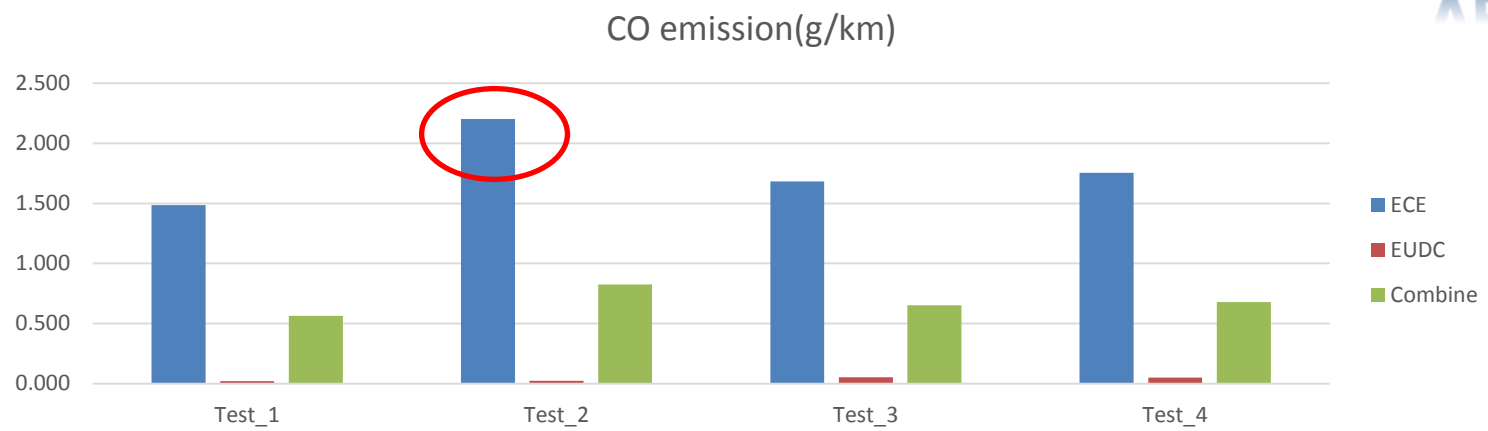
- Elysee gaseous emission modal

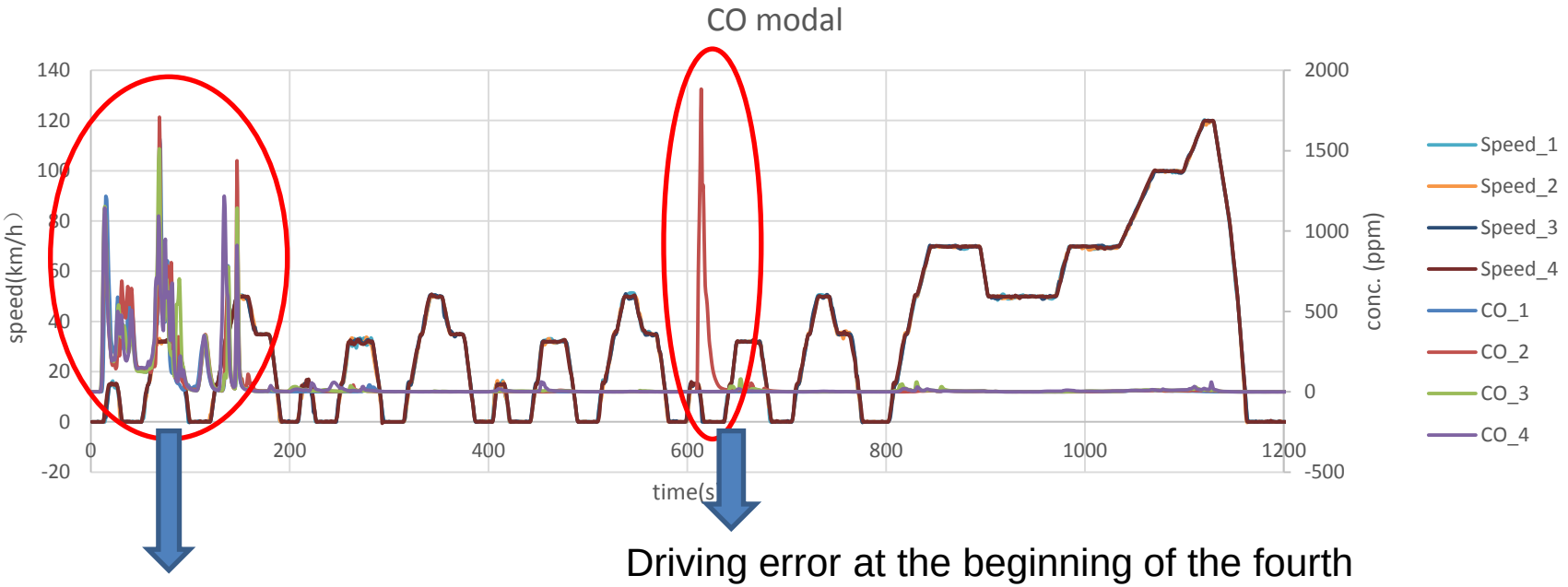


A huge number of emissions emitted even after TWC was heated, probably the malfunction of emission control system.

➢ Accord NEDC Phase Emission Analysis

- CO emission

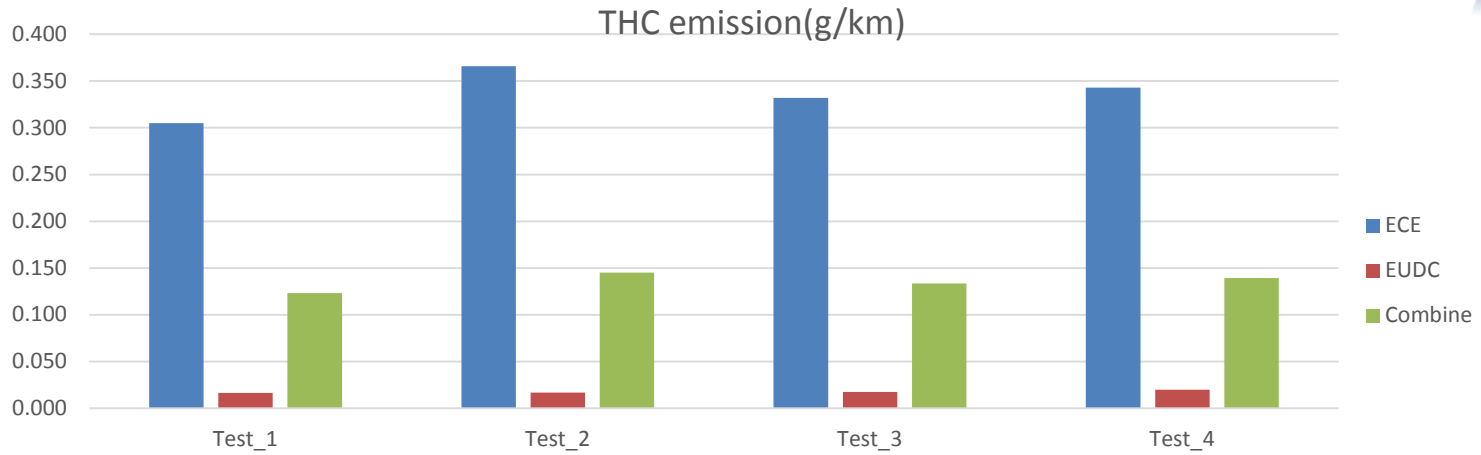


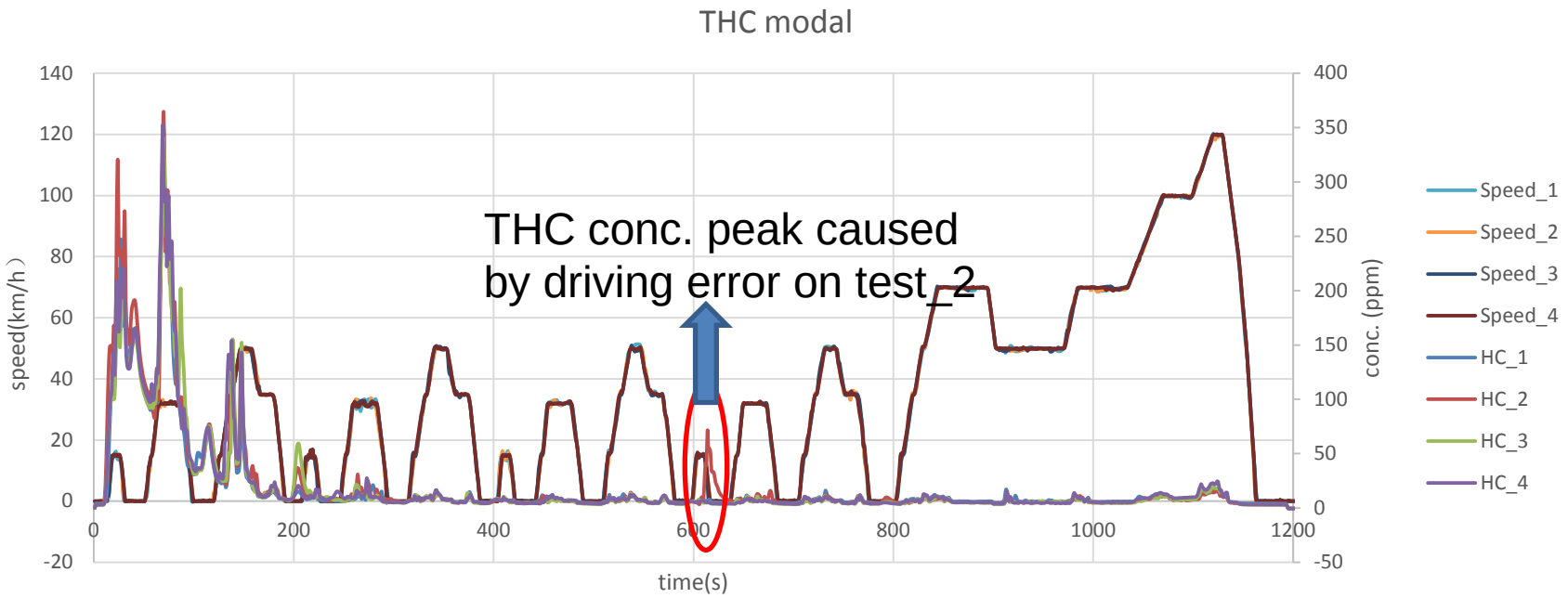


Cold start period emits over 90% of total emission!

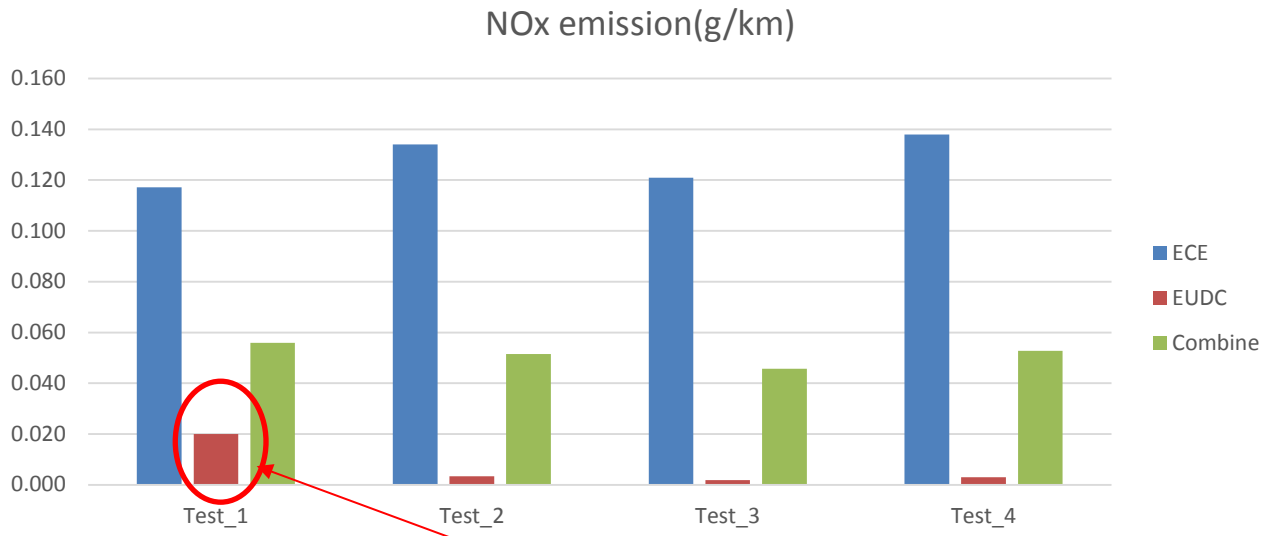
Driving error at the beginning of the fourth ECE15,which lead to higher CO emission on test_2. (driver push the pedal hard when he found speed come to lower limit.)

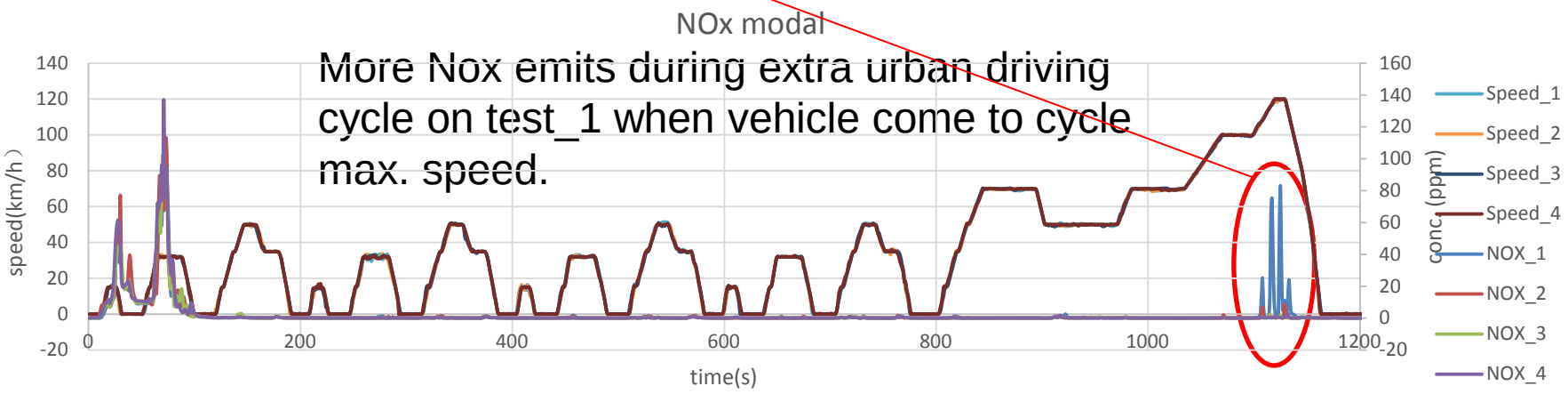
- THC emission





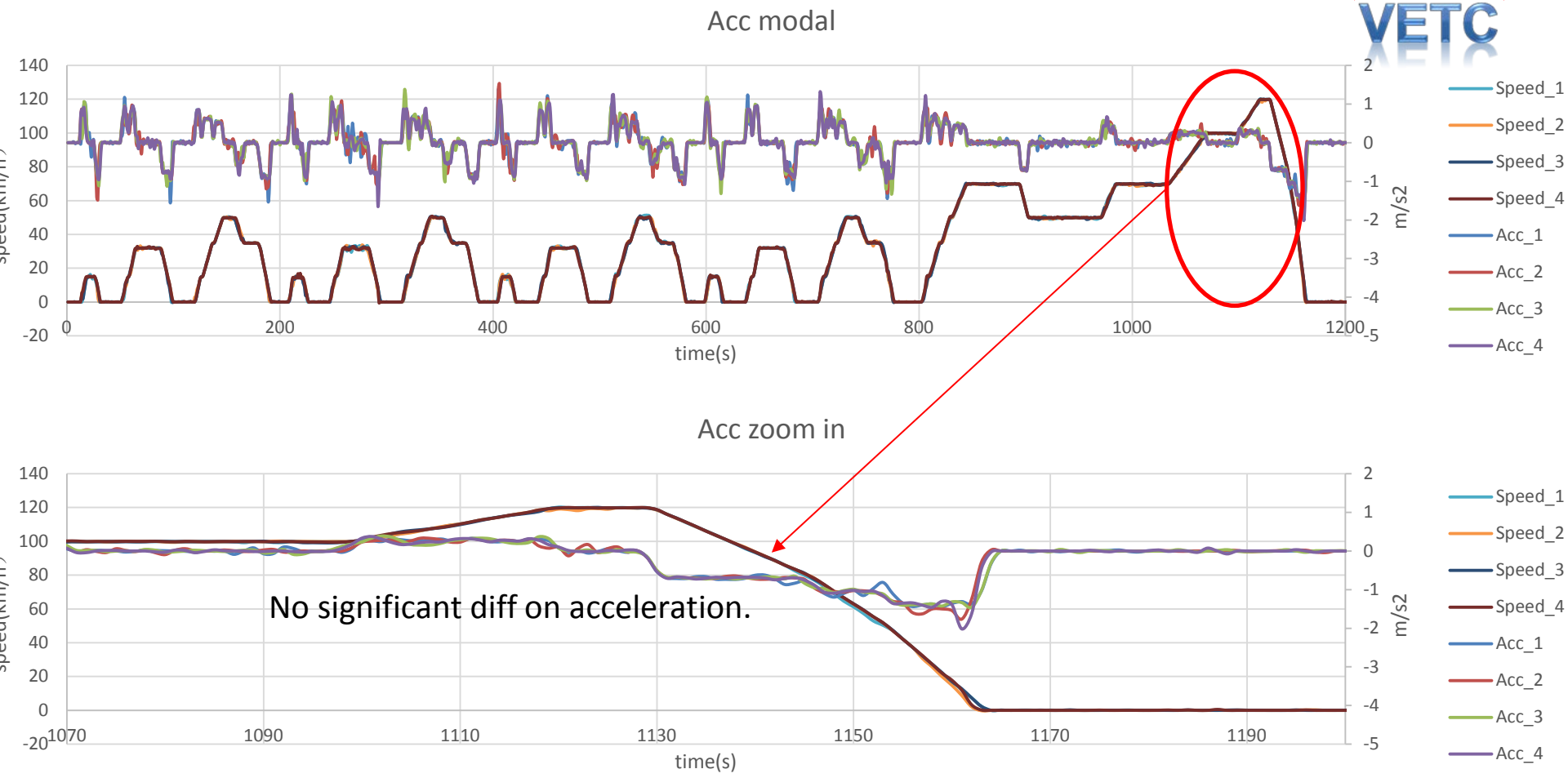
- NOx emission





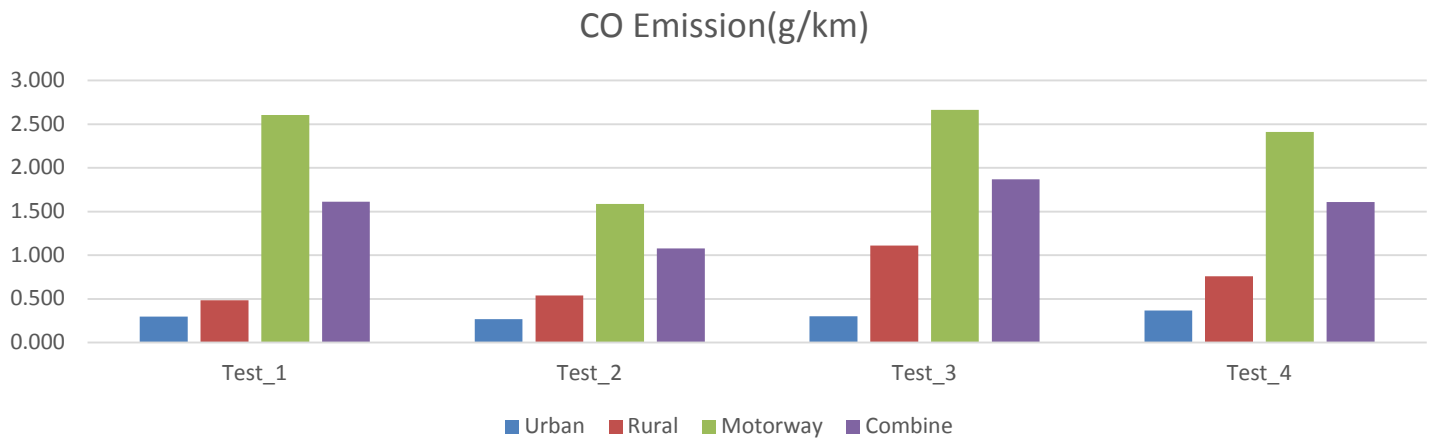
Let's compare the acceleration on next slide.

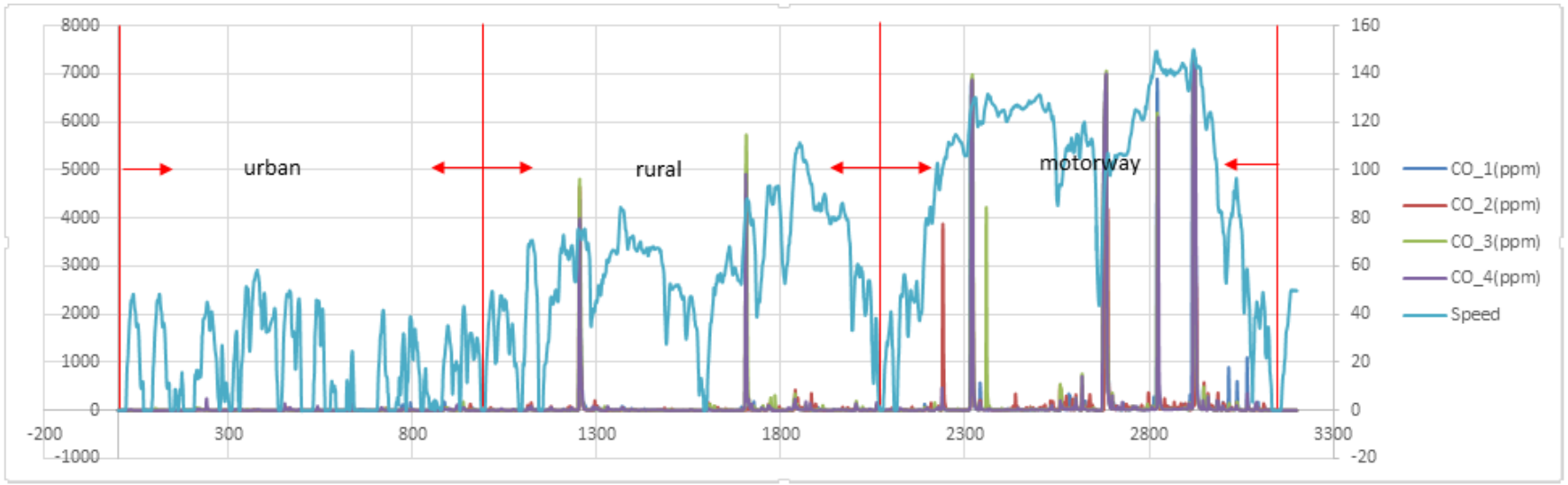
- Acceleration compare



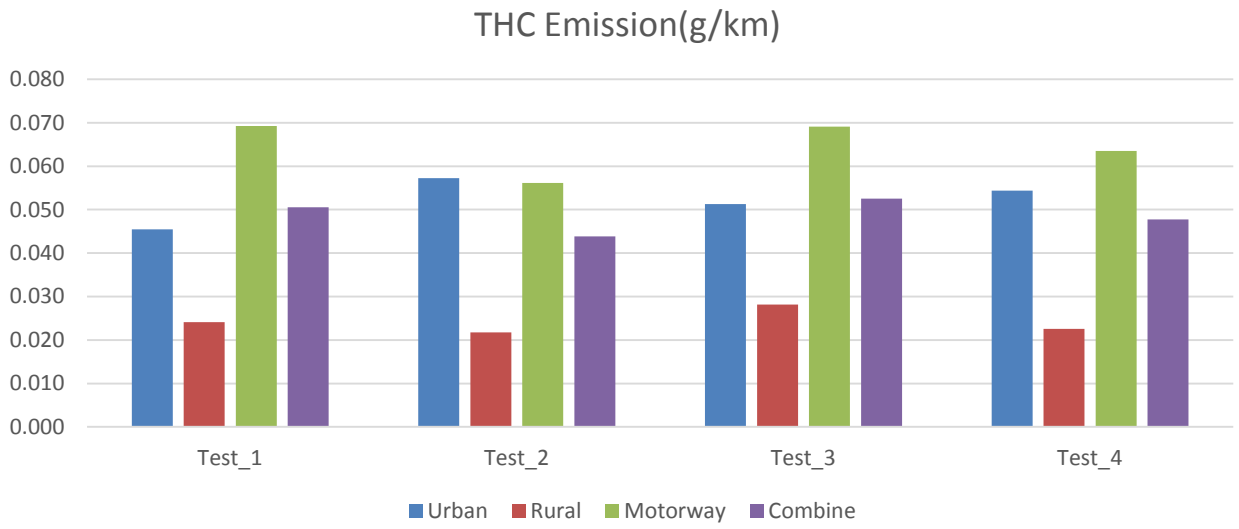
➢ Accord CADC Phase Emission Analysis

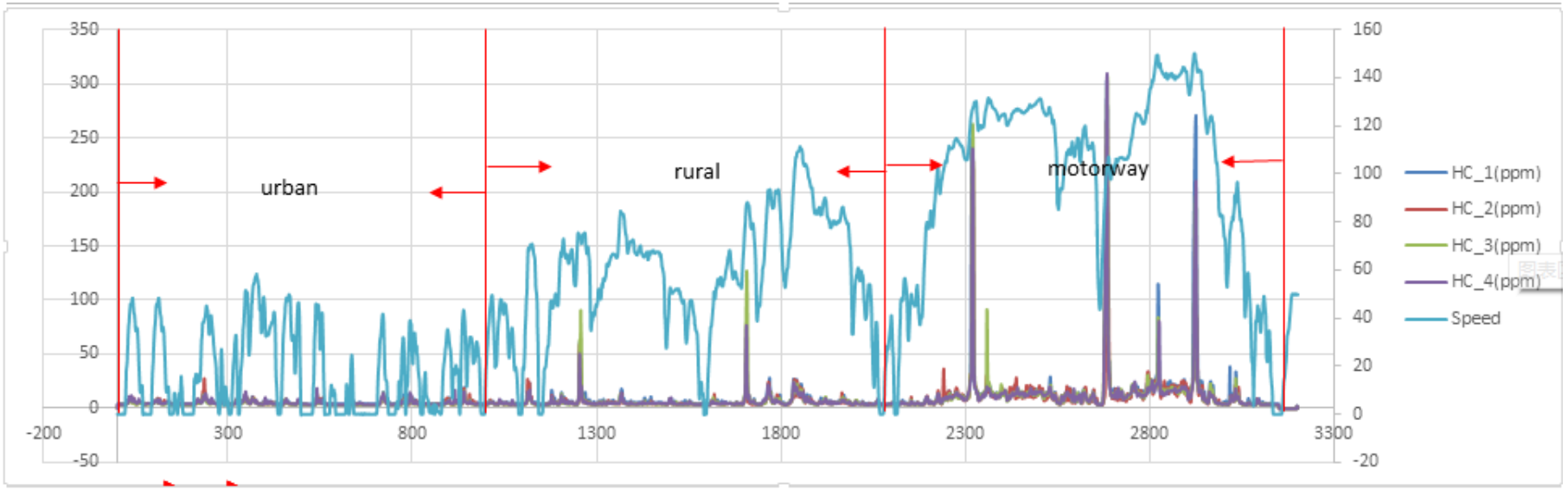
- CO emission



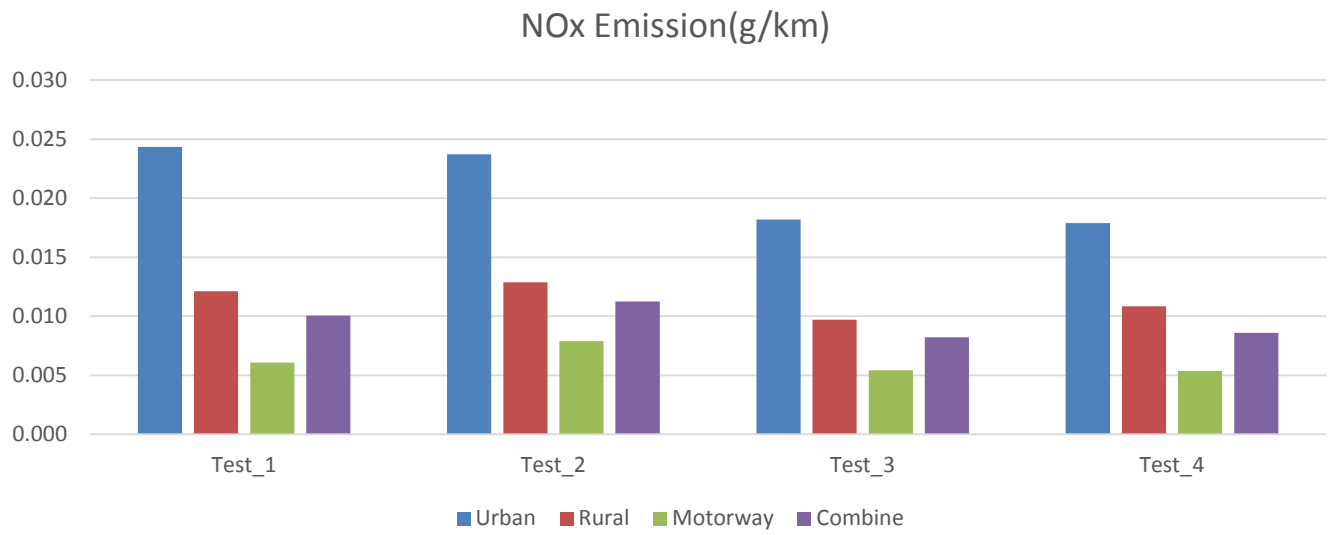


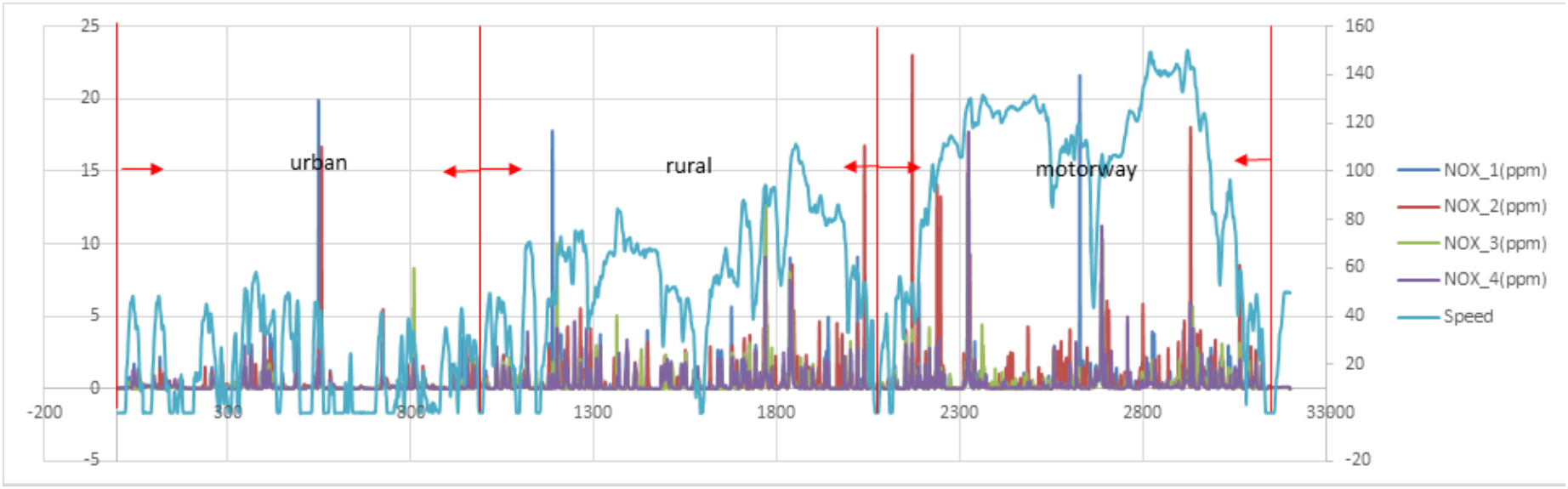
- THC emission



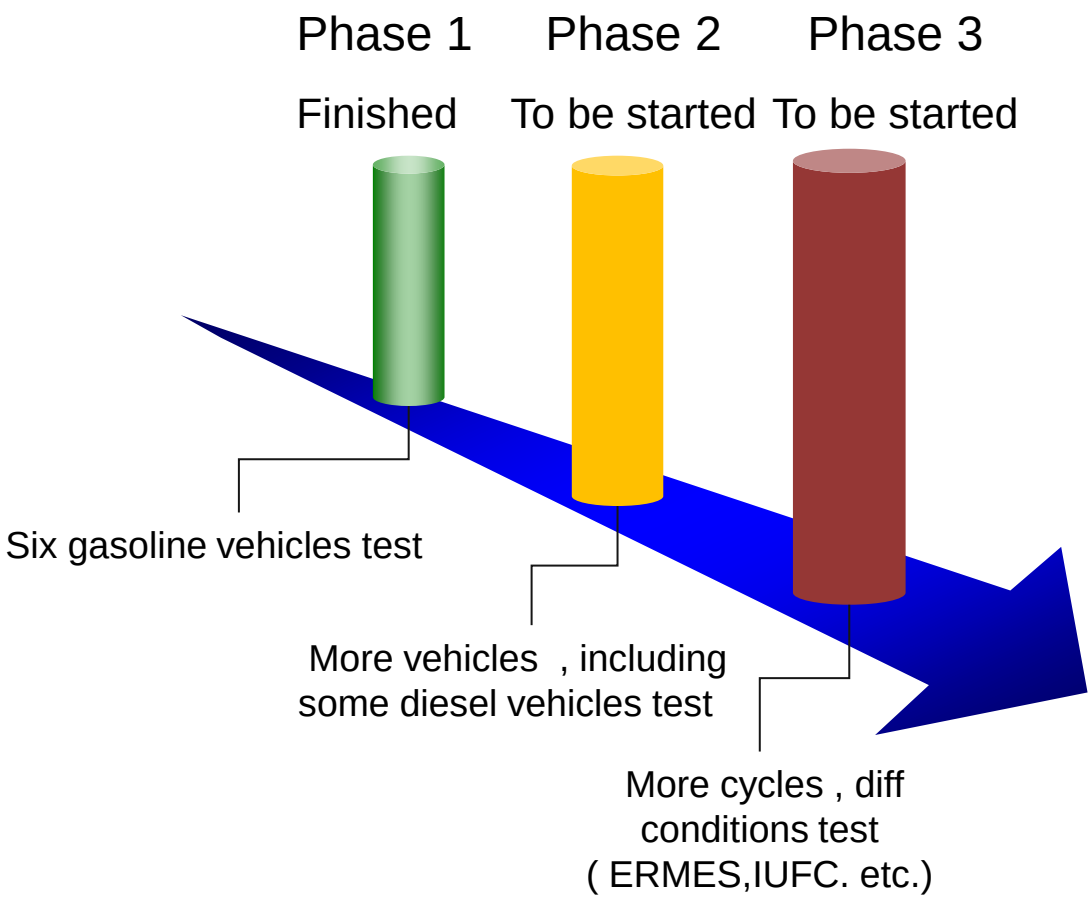


- NOx emission





Further Work




Thank you !