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Automotive fuels — Assessing the effects of E10 petrol on vehicle emissions and performance

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Automotive fuels - Assessing the effects of E10 petrol on vehicle emissions and performance

Carburants pour automobiles - Evaluation des effets de l'essence E10 sur les émissions de véhicules et leurs performances

Kraftstoffe für Kraftfahrzeuge - Beurteilung der Auswirkung von E10-Kraftstoff auf Kraftfahrzeugemission und -leistung

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Foreword

This document (CEN/TR 16569:2013) has been prepared by Technical Committee CEN/TC 19 “Gaseous and liquid fuels, lubricants and related products of petroleum, synthetic and biological origin”, the secretariat of which is held by NEN.

1 Scope

This Technical Report describes a study executed to evaluate the performance of representative vehicles of current and recent production when operating on petrol fuels containing up to 10 % (*V/V*) ethanol. Vehicle performance evaluations included regulated and evaporative emissions as well as hot and cold weather driveability. The testing procedures used in each of the three main vehicle studies were adapted to the requirements of the testing facilities.

The studies were designed to demonstrate whether a relaxation in the $E70_{max}$, $E100_{max}$, and VLI limits in EN 228 would introduce unacceptable vehicle driveability or regulated emissions performance problems. The results were used to advise CEN/TC 19/WG 21 on the revision of the EN 228 petrol specification [1]. A procedure for future revision of EN 228 (see Annex A) was also developed.

2 Background

The former European EN 228 specification [1] included volatility requirements for unleaded petrol in order to ensure good performance of vehicles in real world driving conditions. These requirements were put in place following extensive technical studies in the 1990's at a time when vehicles were more sensitive to volatility than they are today and when blending of oxygenates, like ethanol, was not widespread. Different petrol volatility classes are included in the EN 228 specification that depend on climatic conditions. Minimum and maximum volatility limits for summer and winter petrols are included as well as additional limits for spring and autumn seasonal transitions.

Since these volatility requirements were put in place, the use of oxygenate blending components, such as ethanol and ethers, has increased, in response to the EU Renewable Energy Directive (RED, 2009/28/EC [3]). This Directive requires Member States to use at least 10 % renewable energy in transport fuels by 2020. Although biogas, renewable electricity, and other energy types are encouraged, only conventional and some advanced bio-blending components are likely to be available in sufficient volumes by 2020 to meet the mandate. The major bio-derived blending components until 2020 are likely to be bio-ethanol produced from sugar fermentation, ethers manufactured from bio-ethanol or bio-methanol, and esters and hydrocarbons produced from vegetable oils and animal fats.

Blending ethanol into gasoline at low concentrations alters the volatility characteristics of the resulting blend and the fuel refining and blending process shall account for this effect. In addition to increasing the vapour pressure of the ethanol/petrol blend, ethanol also changes the shape of the blend's distillation curve. This has the potential to impact the vehicle's regulated emissions and driveability performance in cold and hot weather. Furthermore, any change in the blend's distillation characteristics due to ethanol addition must be compensated in the refinery by changing the composition of the hydrocarbon-only petrol mixture into which the ethanol is ultimately blended.

Following the publication of the EU Fuels Quality Directive (FQD, 2009/30/EC [3]), CEN/TC 19 reviewed the European EN 228 unleaded petrol specification in order to enable the higher ethanol blending envisioned by the FQD from 5 % (*V/V)* up to 10 % (*V/V)*. As input to this review, CEN/TC 19 Working Group 21 (WG 21) reviewed a 2009 study of published literature [4] on the effect of blending up to 20 % (*V/V*) ethanol on E70[1] and E100[2] volatility parameters, as well as on hot and cold weather vehicle driveability performance. This literature review was completed to better understand the observed effects on the petrol distillation curve due to the addition of higher levels of ethanol to petrol [5].

Any changes to CEN specifications for fuel parameters beyond those required by EU legislation should be based on the best-available technical data and shall not impact the performance of the vehicle fleet. Based on its review of the existing literature, WG 21 concluded that additional vehicle studies were warranted in order to assess the effects of 10 % (*V/V)* ethanol in petrol on current and future engines (Euro 5 and 6), especially with respect to vehicle regulated and evaporative emissions, CO_2, and hot and cold weather driveability performance.

Summer and winter grade petrols containing 10 % (*V/V)* ethanol were specially blended for this study that had volatility specifications at today's EN 228 maximum limits and at higher limits consistent with CONCAWE's volatility relaxation proposal. The vapour pressures (measured as Dry Vapour Pressure Equivalent (DVPE)) targeted summer grade petrols with a maximum 60 kPa DVPE and winter grade petrols with a maximum 100 kPa DVPE. The DVPE of the test fuel was selected to be consistent with the type of vehicle test that was completed.

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[1] The percentage of a petrol sample that evaporates at 70 °C

[2] The percentage of a petrol sample that evaporates at 100 °C

In order to give sufficient technical input on behalf of CEN/TC 19 WG 21 members, a Volatility Task Force (VTF) was established in December 2010. Experts were nominated from WG 21 stakeholders and primarily from ACEA and CONCAWE, under the leadership of the WG 21 Chair and NEN Secretary.

The VTF met for the first time on 21 February 2011 and in total 21 meetings or web-conferences were held. Eight reports to WG 21 were issued and three presentations were given at WG 21 meetings.

3 Fuel selection

The VTF agreed to use a common set of specially blended test fuels to test the effect of the proposed relaxation in the volatility limits. The test fuels were based on early indications by CONCAWE on what qualities (mainly regarding volatility parameters) could be expected in the future when more refineries are supplying E10 fuels. Other options are also considered for the blending of E10 petrol, i.e. ETBE up to the 3,7% (*m/m*) oxygen content limit and ETBE + E5 blends up to the 3,7 % (*m/m*) oxygen content limit. The fuel matrix covered summer (class A) and winter (class E1) petrols as shown in Table 1.

Table 1 — Targets and measured values for test fuels

Baseline Fuels			
Summer (Class A)		**Winter (Class E1)**	
CEC RF-02-08 (Condition and pretest fuel)			
Target values:	Measured values:		
60 kPa $DVPE_{max}$ 5 % (*V/V*) Ethanol E70 mid-range E100 mid-range	58,7 kPa DVPE 4,7 % (*V/V*) Ethanol 37,0 % E70 53,5 % E100		
Baseline E10-A		**Baseline E10-E**	
Target values:	Measured values:	Target values:	Measured values:
60 kPa $DVPE_{max}$ 10 % (*V/V*) Ethanol 48 % $E70_{max}$ Class A 71 % $E100_{max}$ Class A	57,1 kPa DVPE 9,7 % (*V/V*) Ethanol 49,7 % E70 68,4 % E100 918,9 VLI	95 kPa DVPE 10 % (*V/V*) Ethanol 50 % $E70_{max}$ Class E 71 % $E100_{max}$ Class E	97,0 kPa DVPE 9,5 % (*V/V*) Ethanol 51,9 % E70 67,1 % E100 1333,3 VLI
Relaxed Volatility Fuels			
Summer (Class A)		**Winter (Class E1)**	
Step 1 E10-A		**Step 1 E10-E**	
Target values:	Measured values:	Target values:	Measured values:
60 kPa DVPEmax 10 % (V/V) Ethanol 52 % E70 (max+4 %) 73 % E100 (max+2 %)	58,7 kPa DVPE 9,5 % (V/V) Ethanol 52,9 % (V/V) E70 73,2 % (V/V) E100 957,3 VLI	95 kPa DVPE 10 % (V/V) Ethanol 54 % E70 (max+4 %) 73 % E100 (max+2 %)	93,2 kPa DVPE 9,5 % (V/V) Ethanol 54,9 % E70 70,9 % E100 1316,3 VLI
Step 2 E10-A		**Step 2 E10-E**	
Target values:	Measured values:	Target values:	Measured values:
60 kPa DVPEmax 10 % (V/V) Ethanol 58 % E70 (max+10 %) 75 % E100 (max+4 %)	61,0 kPa DVPE 9,4 % (V/V) Ethanol 59,4 % (V/V) E70 75,7 % (V/V) E100 1025,8 VLI	95 kPa DVPE 10 % (V/V) Ethanol 60 % E70 (max+10 %) 75 % E100 (max+4 %)	94,1 kPa DVPE 9,4 % (V/V) Ethanol 60,6 % E70 73,9 % E100 1365,2 VLI

4 CONCAWE vehicle study - High-level summary of results

CONCAWE tested six vehicles to investigate the impact of changes in the volatility characteristics of unleaded gasoline containing 10 % (*V/V)* ethanol on regulated exhaust and evaporative emissions and on hot and cold weather vehicle driveability performance. The vehicles selected for this study were representative of the current EU fleet, met or exceeded Euro 4 emissions limits, spanned the range from upper medium to small vehicle classes, were compatible with 10 % (*V/V*) ethanol according to the manufacturer's warranty information, and included two modern gasoline DISI engine types.

Table 2 — Characteristics of vehicles evaluated in the CONCAWE study

Vehicle No.	**1**	**2**	**3**	**4**	**5**	**6**
Vehicle Class	Upper Medium	Medium	Small	Lower Medium	Mini	Small
Category	M1	M1	M1	M1	M1	M1
Emissions Homologation	Euro 4	Euro 5	Euro 4	Euro 4	Euro 4	Euro 4
Engine Displacement (litres)	2.5	1.8	1.4	1.6	1.0	1.25
Max. Power (kW)	140	118	57	80.5	50	60
Inertia Class (kg)	1590	1470	1130	1360	910	1020
Cylinder	6	4	4	4	3	4
Valves	24	16	8	16	12	16
Aspiration	Natural	Turbo	Natural	Natural	Natural	Natural
Combustion Type	Homogeneous stoichiometric	Homogeneous stoichiometric	Homogeneous stoichiometric	Homogeneous stoichiometric	Homogeneous stoichiometric	Homogeneous stoichiometric
Injection System	Direct Injection	Direct Injection	Sequential Fuel Injection	Sequential Fuel Injection	Sequential Fuel Injection	Sequential Fuel Injection
After-treatment device	Three-way Catalyst	Three-way Catalyst	Three-way Catalyst	Three-way Catalyst	Three-way Catalyst	Three-way Catalyst
Rear or Front Wheel Drive	Rear	Front	Front	Front	Front	Front
Transmission	Manual 6-speed	Manual 6-speed	Manual 5-speed	Manual 6-speed	Manual 5-speed	Manual 5-speed
Drive by wire?	Yes	Yes	Yes	Yes	No	Yes
Traction control?	Yes	Yes	Yes	Yes	No	No
E10 Compatible?	Yes	Yes	Yes	Yes	Yes	Yes
Registration Date	15/06/2007	04/06/2009	29/09/2007	29/09/2009	23/07/2008	28/01/2010
Mileage at start of test (miles)	23,354	8,890	21,496	14,934	13,704	15,607

Vehicle testing included regulated emissions measured over the New European Driving Cycle (NEDC) at +23 °C and -7 °C, evaporative emissions according to the European regulatory procedure, cold engine starting and idling at -20 °C, and Hot Weather Driveability performance at +40 °C.

CONCAWE's conclusions from this study [6] were:

- All vehicles satisfactorily completed all required driving cycles on all fuels with no false starts, no misfires, no stalls, no failures, and no OBD faults.
- Impacts of fuel volatility on emissions and performance were small relative to vehicle-to-vehicle effects.
- No major differences were observed in the fleet-average HC and NOx emissions between the Baseline E10-A and Step 2 E10-A fuels for NEDC regulated emissions at +23 °C. The fleet-average CO emissions were 36 % higher on the more volatile Step 2 fuel but were still well below the Euro 4/5 limits for this test.
- No major differences were observed between the Baseline E10 and Step 2 E10 fuels for fleet-average NEDC regulated emissions at -7 °C and for HWD performance at +40 °C.
- Cold operation at -20 °C and -7 °C:
  - Overall conclusions:
    - > The measurement of lambda at these cold conditions was critical to understanding the in-cylinder conditions and the resulting impacts on emissions. The following conclusions apply particularly to the -20 °C results and to a limited extent the -7 °C results.
      - The exhaust UEGO sensor data indicated that the Step 2 E10-E fuel gave slightly richer lambda during the initial warm-up period. These results were not supported, however, by direct measurements of fuel and air flow, which suggested that there was no difference in AFR between the fuels.
      - The reason for these apparently conflicting results is not clear, but it is possible that the UEGO sensor responded to differences in exhaust composition between the two fuels rather than to a change in overall AFR. Alternatively, the lower volatility of the Baseline E10-E fuel may result in some fuel being retained on the cylinder wall during the initial cold engine conditions. If this were the case, then this fraction of fuel would not participate in the combustion process and would not appear in the exhaust gas.
      - Although conditions in the combustion chamber could not be directly measured, it can be expected that the more volatile Step 2 E10-E fuel should give better evaporation and mixing even in a cold combustion chamber. It is not clear whether the overall effects of this are beneficial or detrimental.
  - Cold starting and Idling at -20 °C:
    - > The tests comparing the Baseline E10-E fuel with the Step 2 E10-E fuel, having a difference in E70 of 8,7 %, showed:
      - All vehicles started easily (<1,6 s) and satisfactorily completed the 1180s test. Idle speeds were stable and consistent throughout and showed no differences between the fuels, although there were differences between vehicles in terms of fuel consumption, emissions, and time to reach lambda control.
      - Compared to the Baseline E10-E fuel, the more volatile Step 2 E10-E fuel produced more CO, less CO_2, and slightly lower levels of unburned HCs in the exhaust.
      - Limited tests comparing the Step 1 E10-E fuel with the Baseline E10-E fuel, which differed in E70 by 3 %, showed very similar emissions and starting performance.
- ECE regulated emissions at -7 °C:
  - The tests comparing the Baseline E10-E fuel with the Step 2 E10-E fuel, having a difference in E70 of 8,7 %, showed:
    - > CO and HC emissions on all fuels were well below the ECE regulated limits.
    - > Higher fleet-average CO emissions were measured on the Step 2 E10-E fuel although the effect was dominated by one DISI vehicle (Vehicle 2).
- Evaporative Emissions
  - Hot Soak Loss (HSL) emissions were low for all tests and fuels and the evaporative emissions results were dominated by diurnal emissions.

- Three of the vehicles met the 2 g/test emission limit in all tests, but the other three vehicles consistently exceeded this limit, by up to 100 %.
- Substantial differences were found between repeat tests on the same fuel, so the data were not adequate to carry out statistical analysis. However, there were no clear differences in emissions for any of the vehicles between the Baseline E10-A and Step 2 E10-A fuels.
- Additional diurnal tests with extra carbon canisters connected to the vehicle canister vents showed that the diurnal emissions were not due to canister breakthrough, but from other sources, possibly including permeation through fuel system materials.

- Hot Weather Driveability (HWD) at +40 °C:
  - No overall increase in demerits was observed with the Step 2 E10-A fuel compared to the Baseline E10-A fuel for hesitations, stumbles and surges and for idle instability. For these demerit types 5 of 6 vehicles showed lower demerits on the Step 2 E10-A fuel, and one vehicle showed similar demerits on both fuels.
  - The two smaller vehicles showed higher demerits due to idle instability during Sequence 6 (heavy city traffic driving). This was due to greater idle speed variation than expected after throttle opening and closing.
  - Total demerits were higher than expected for all fuels when acceleration demerits were included, but these are believed to be due to the Engine Management System not allowing full throttle when demanded by the driver.

Overall, CONCAWE concluded that the results of this six-vehicle testing supported the conclusion from previously published studies that a small relaxation in the $E70_{max}$ and $E100_{max}$ volatility parameters in the EN 228 gasoline specification would not be expected to increase the risk of regulated emissions or vehicle driveability performance problems. The majority of the tests completed in this study compared results between ‘Baseline’ and ‘Step 2’ gasolines, in order to provide greater confidence that the performance of ‘Step 1’ gasolines would also be acceptable in real-world use. This conclusion applied to the current fleet of European gasoline vehicles as represented by the six E10-compatible vehicles selected for this study.

5 OEM vehicle studies - high-level summary of results

In order to help evaluate the changes to $E70_{min}$, $E70_{max}$ and $E100_{max}$ that were proposed by CONCAWE, four vehicle manufacturers undertook and funded individual test programs on a range of representative vehicles and fuels (see Annex B for details of the various tests and the fuels evaluated). The results of the tests are summarised in Table 3.

The results were discussed in the VTF in order that all stakeholders were able to review and question the results. Some of the 4 vehicle manufacturers also had additional discussions with representatives of oil companies where they have a working relationship.

The results on these new fuel formulations clearly showed that, under certain tests, fuel-related effects were observed at a level that the specific vehicle manufacturer categorised as being a concern when compared against vehicle sign-off criteria and also based on expert engineering judgement.

The vehicles tested were signed-off for production under the strictest engineering conditions using fuel formulations know at the time of sign-off. The tests demonstrated that there would be a risk that customers would experience problems using such ‘new fuels’ that are outside the validation area for the vehicles.

The vehicle manufacturers cannot accept any risk that their customers would experience problems using ‘new fuels’ that have not been evaluated in all the development and testing programs that are necessary to sign-off of new vehicles. Any complaints of poor vehicle operation would come directly to the vehicle manufacturers and their dealers and the vehicle manufacturers cannot accept this burden.

Table 3 — OEM study results

Summer Fuels	**Renault**	**PSA**	**Ford**	**Mercedes-Benz**
NEDC (+23 °C)	No Data	↑ CO Step 1	No Data	Step 2
NEDC (-7 °C)	No Data	No Data	No Data	Step 2
Cold Start (-20 °C)	Step 1	Step 1 lambda	No Data	Step 2 (at -25 °C)
HWD (+40 °C)	Step 1	No Data	No Data	Step 2 vapor lock
Evaporative Emissions	Step 1	No Data	No Data	Step 2
Winter Fuels				
NEDC (+23 °C)	No Data	↑ CO Step 1	Step 2	Step 2 CO above limit
NEDC (-7 °C)	No Data	No Data	Step 2	Step 2
Cold Start (-7 °C)	Step 1 (at 0 °C), lambda leaner, engine speed	No Data	Step 2 ↑Misfire	No Data
Cold Start (-20 °C)	Step 1 lambda leaner, potential for stalling	Step 1 lambda	Step 2	Step 2 (at -25C)
HWD (+40 °C)	Step 1 (at 30 °C) lack of richness	No Data	Step 2	Step 2 vapor lock and odour
Evaporative Emissions	Step 1	No Data	No Data	Step 2 slightly ↑

Colour Codes:
Green: no significant effects were observed;
Yellow: some effects were observed;
Red: effects were observed that the data originator categorized as a concern or a fail based on their engineering judgment and vehicle sign-off criteria.

In summary:

- Mercedes-Benz declared that the evaluated fuels were not accepted for their vehicles.
- Ford declared that the evaluated fuels were not accepted for their vehicles.
- PSA Peugeot Citroën declared that the evaluated fuels were not accepted for their vehicles.
- Renault declared that the evaluated fuels were not accepted for their vehicles.

In addition, vehicle manufacturers declared the results of these limited tests cannot be extrapolated to the whole vehicle fleet, current or planned.

The results of the test conducted by the four vehicle manufacturers were provided to WG 21 in document CEN/TC 19/WG 21/N 255 [7].

6 Applus IDIADA vehicle study

6.1 Study background

A third study was designed to conduct targeted testing on high-mileage passenger cars. To complete and fund this study, NEN developed a project proposal based on a tender call from the European Commission under the 7th Framework Partnership Programme. Following an analysis of the tender bids, the vehicle study was contracted to Applus IDIADA in Spain. The Volatility Task Force managed the project on behalf of NEN through regular teleconferences and email exchanges.

Based on IDIADA's offer, the available budget from the EC, and the preliminary results from the other two test programmes, the VTF decided to limit the number of tests and fuels for this study on used vehicles. Many of the same fuels that were tested in the other two studies were shipped by CONCAWE to the testing facility. IDIADA supplemented with CEC reference fuel from their own supply.

The fuels tested by IDIADA were:

Test type	**Fuel type**			
Evaporative emissions	Gasoline Euro 4	E10-A Baseline	E10-A Step 1	E10-A Step 2
Exhaust emissions @ ambient temp.	Gasoline Euro 4	E10-A Baseline	E10-A Step 1	E10-A Step 2
Exhaust emissions @ -7 ^{o}C	Gasoline Euro 4	E10-A Baseline	E10-A Step 1	E10-A Step 2
Hot start and drive @ +40 ^{o}C	CEC RF-02-08	E10-A Baseline	E10-A Step 1	E10-A Step 2
Cold start plus idle @ -20 ^{o}C	E5-E Market Fuel	E10-E Baseline	E10-E Step 1	E10-E Step 2

Vehicle tests similar to those conducted in the other two studies were carried out to assess cold and hot fuel handling and vehicle driveability effects as well as evaporative emissions. The following tests were carried out:

— Coastdown tests,

— Exhaust emission test Type I according to the Euro 4 Regulation,

— Evaporative emission test Type IV according to the Euro 4 Regulation,

— Exhaust emission test Type VI at -7 ^{o}C according to the Euro 4 Regulation,

— Cold engine starting and idling test at -20 ^{o}C, and

— Hot weather driveability test at +40 ^{o}C.

The test procedures were largely based on regular (standard) test procedures as defined in EU Regulations with limited adaptations in order to optimize the correlation with actual driveability performance. Alternative procedures were discussed by the VTF and it was agreed in the end to stay in line with the procedures used in the CONCAWE study as much as possible in order to improve the comparison of results. These procedures and results did not compare exactly with the parallel ACEA programme, but the OEM representatives to the VTF indicated they might derive conclusions from the results. Exhaust tests were performed at ambient and cold temperature starting along with additional OBD monitoring.

6.2 Vehicle selection and preparation

In cooperation with IDIADA, four used passenger cars were sourced for this study in order to provide an indication on the impact of the gasoline volatility proposal on vehicle performance. The intention was that each vehicle would represent a worst-case scenario based on the type of engine and its presumed sensitivity to gasoline volatility. The four cars selected for this study are shown in Table 4.

Table 4 — Characteristics of vehicles evaluated in the Applus IDIADA study

Vehicle No.	1	2	3	4
Vehicle Make and Model	OPEL ZAFIRA OPC	VW GOLF	VW TOURAN	OPEL CORSA
Vehicle Class	Upper Medium	Medium	Upper Medium	Small
Category	M1	M1	M1	M1
Emission Standard (homologation)	Euro 4	Euro 4	Euro 4	Euro 4
Engine Displacement (litres)	2.0	1.4	1.6	1.2
Max. Power (kW)	177	90	75	59
Inertia Class (kg)	1717	1406	1590	1249
Cylinder	4	4	4	4
Valves	16	16	8	16
Aspiration	Turbo	Turbo	Natural	Natural
Combustion Type	Homogeneous stoichiometric	Homogeneous stoichiometric	Homogeneous stoichiometric	Homogeneous stoichiometric
Injection System	Sequential Injection	Direct Injection	Sequential Injection	Sequential Injection
After-treatment device	Three-Way Catalyst	Three-Way Catalyst	Three-Way Catalyst	Three-Way Catalyst
Rear or Front-Wheel Drive	Front	Front	Front	Front
Transmission	Manual 6-speed	Manual 6-speed	Manual 6-speed	Manual 5-speed
Drive by Wire?	Yes	Yes	Yes	Yes
Traction Control?	Yes	Yes	Yes	No
E10 Compatible?	Yes	Yes	Yes	Yes
Registration Date	March 2006	June 2008	October 2004	May 2008
Mileage at start of test (miles)	52,009	48,195	47,671	34,501

Based on engineering considerations, these vehicles were selected for the following reasons:

1. 2006 Opel Zafira OPC: an SFI turbo engine potentially considered to be sensitive to hot starting driveability problems. This all-wheel drive vehicle had the highest road load, highest weight and highest aerodynamic drag.
2. 2008 VW Golf 1.4TSI: a PFI turbo engine potentially considered to be sensitive to cold engine starting and idling. The engine was observed to have the longest warm-up period and the longest time operating in open-loop mode. This vehicle had the lightest body and the lowest road load.
3. 2004 VE Touran 1.6T: an SFI engine without turbocharger considered potentially to be sensitive to hot starting driveability problems. This high-volume car has a relatively small engine and high road load.
4. 2008 Opel Corsa: an SFI engine without turbocharger considered potentially to be sensitive to cold engine warm-up and idling. This high-volume car in the C/D segment has a small but efficient engine with a low road load.

All four vehicles were sourced from used car dealers or leasing operations in Spain. To be selected, the cars were expected to have about 50,000 km of service and be in good working order. There were some initial issues with the Corsa that were solved by IDIADA maintenance. The Touran showed exceptionally high CO emissions and lambda behaviour. On advice of VW, this car was assessed at a VW dealership and the lambda sensor was replaced. This extra maintenance caused the emissions testing on the Touran to occur after the cold start and hot weather driveability assessments.

All tests by IDIADA were completed by the 21st June, 2012 and a report supplied [8]. The VTF assessed all of the results and concluded that the results on E10 gasolines having different volatility specifications did not introduce any new or unexpected problems.

6.3 High-level summary of results

On the Type 1 exhaust emission test at ambient temperatures, some vehicles showed an increase in the CO emissions with the use of E10 fuels but not above the allowed limits and not consistently with each fuel. The Opel Zafira, VW Golf and Opel Corsa showed no significant differences in the HC and NOx emissions between the four test fuels tested. Although the VW Touran showed no significant differences in HC emissions among the four fuels tested, the NOx emissions showed higher variability but it was difficult to identify a consistent trend. As expected, a slight increase in volumetric fuel consumption was observed with the E10 gasolines, compared to the reference Euro 4 gasoline, with all four vehicles.

On the Type IV evaporative emission test, all four cars passed the evaporative emissions test with all fuels. Although the vehicles did not fail the Type IV test, there was an impact of the fuels on absolute evaporative emissions, increasing the emissions in three of the four cars. During this test, two vehicles (VW Golf and Opel Corsa) showed small increases in HC emissions while the VW Touran and Opel Zafira showed more consistent results. These might be explained by the test order or problems associated with the evaporative canister performance.

In the Type VI exhaust emission test at -7 °C, there was a tendency to increase the CO emissions with all of the E10 fuels in all of the test cars. For three vehicles, an increase in CO emissions with the E10-A Step 1 and E10-A Step 2 fuels was observed. The increase was larger than observed with the E10-A Baseline gasoline, which was also larger than observed when the Euro 4 reference gasoline was tested. On all four vehicles, there was a small tendency to decrease NOx emissions with the E10 gasolines but overall there were not large differences on the four test fuels. A slight decrease in CO_2 emissions was measured with the E10 gasolines compared to the Euro 4 reference gasoline on all four cars. The volumetric fuel consumption increased with the E10 gasolines compared to the Euro 4 reference gasoline in all four vehicles.

It was difficult to draw firm conclusions on the cold engine starting and idling tests because there were several observations that suggested problems with some engines. These problems could not be easily attributed to a single fuel, especially when comparing E10 with the reference gasolines. With the hot weather driveability tests, driveability issues seemed to be more car than engine related and were not detrimental for the overall functioning of the car. For example, the driver in the Opel Corsa observed a lot of driveability demerits but these seemed to be associated with this specific car, when comparing the results in other tests.

7 Revision of petrol volatility requirements in EN 228

Having reviewed the results from the CONCAWE and OEM vehicle studies, preliminary results from the IDIADA study, and related literature, the Volatility Task Force presented its conclusions and recommendations in February 2012. Based on the results, a small relaxation in volatility limits was recommended as shown in Table 5. Here the updates are indicated in red.

This recommendation was accepted by WG 21 in February 2012 and balloted in EN 228:2012. An updated volatility diagram as shown in Figure 1 was also developed by the VTF. The final results from all of the IDIADA tests as per July 2012 did not lead to a different conclusion.

Table 5 — Volatility limits revised in EN 228 specification for E10 gasoline

Property	Units	Limits					
		class A	class B	class C/C1	class D/D1	class E/E1	class F/F1
% evaporated at 70 °C, E70	% (*V/V*), min.	22,0	22,0	24,0	24,0	24,0	24,0
	% (*V/V*), max.	50,0	50,0	52,0	52,0	52,0	52,0
% evaporated at 100 °C, E100	% (*V/V*), min.	46,0	46,0	46,0	46,0	46,0	46,0
	% (*V/V*), max.	72,0	72,0	72,0	72,0	72,0	72,0
Vapour Lock Index (VLI) (10*VP + 7*E70)	index, max.			1064 (C1)	1164 (D1)	1214 (E1)	1264 (F1)

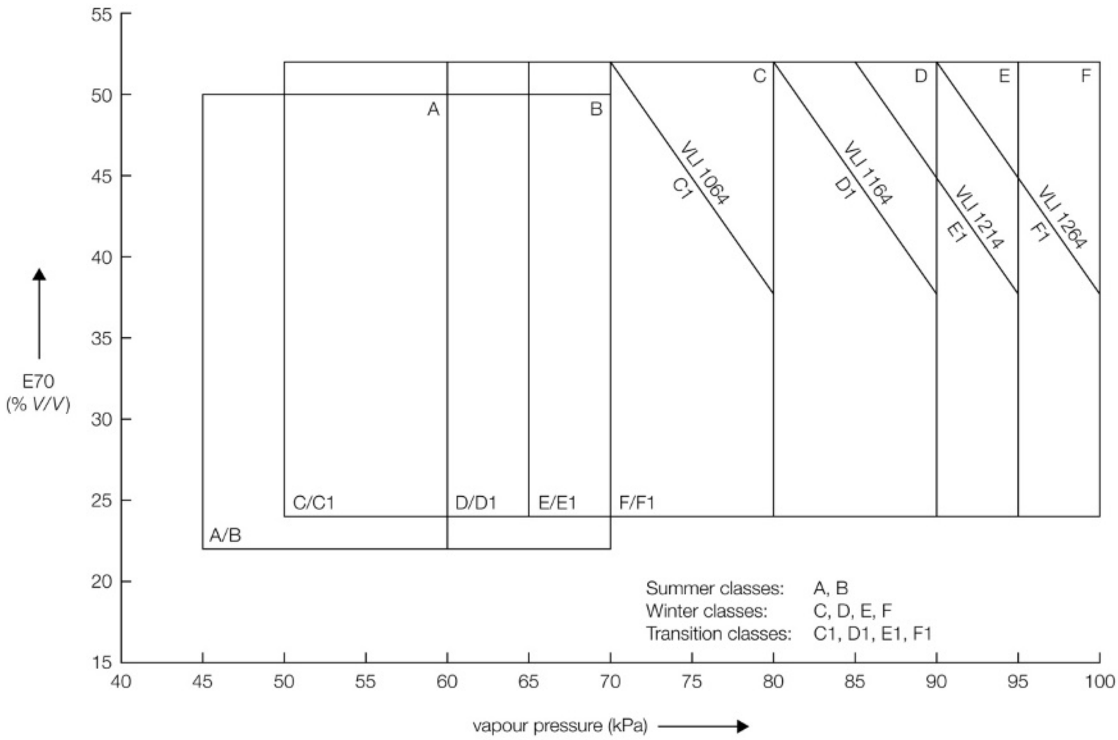

Figure 1 — Diagram of volatility limits in the revised EN 228 specification for E10 gasoline

8 Monitoring vehicle performance in the field

8.1 Introduction

Vehicle performance problems that may be associated with marketplace fuel quality are typically observed either very quickly or only after an extended time. Based on previous field experience, some vehicle problems can quickly be identified directly to fuel quality problems, due to unwanted or unexpected fuel constituents. When these problems have occurred in the past, they have been relatively easy to spot because they caused vehicles to stop (e.g., a reactive silicon component in gasoline) or perform poorly (e.g., corrosion of silver-coated sender gauges in gasoline tanks).

Other vehicle problems have only been realised after a longer time period, for example, through an analysis of fuel survey data or via vehicle problems reported to dealers (within or outside of a vehicle warranty period). Fuel-related problems of this sort usually require vehicles to use similarly-sourced fuel over a longer time and are sometimes associated with the introduction of new fuel system parts. The recently identified problem of internal diesel injector deposits (IDID) in advanced diesel engines appears to be an example.

Because of this difference in field problems, mechanisms to identify and quickly resolve fuel-related problems shall consider both time frames. Field problems related to fuel volatility resulting from the change being introduced in EN 228:20xx could potentially be observed quickly or develop slowly over time, perhaps including transient effects associated with changes in seasonal temperatures and during the cross-over from summer-winter fuel grades (or vice-versa). These problems could also be associated with particular vehicle makes and models and even combined with other types of fuel/vehicle problems beyond volatility. For this reason, four mechanisms are proposed to deal with potential fuel effects in the event that they are observed in the marketplace:

1. Monitor marketplace fuel properties and vehicle performance;
2. Implement immediate remedies through local Member State actions;
3. Revise the EN 228 specification through a CEN/TC 19 procedure for amendment;
4. Conduct joint research to anticipate future fuel-related problems.

8.2 Monitor marketplace fuel properties and vehicle performance:

Monitoring fuel quality and vehicle problems is an essential first step to identify fuel-related problems in the marketplace. Many companies and organisations routinely conduct market surveys on fuels and vehicle performance. Specially commissioned fuel surveys and results of the annual Fuel Quality Monitoring System could also be reviewed periodically for potential problems, perhaps by a group supporting CEN/TC 19 WG 21.

Vehicle warranty claims may also provide useful information on longer-term problems and suitable mechanisms should be put in place by associations/manufacturers and their suppliers in order to evaluate incoming data for potential fuel-related problems. The results of these analyses could be reviewed regularly by the relevant group and brought to the attention of the fuel suppliers or CEN/TC 19 for appropriate action. Older vehicles whose owners choose not to use the dealer networks would need to be similarly informed to support data collection via manufacturer service bulletins.

These data can provide early warning that a problem may be developing in the marketplace but the information is not always reviewed in a timely way for particular fuel and vehicle related problems. Thus, the first step is for appropriate experts to agree on approaches to routinely pool data on market fuels and vehicle performance in a way that is acceptable to all stakeholders and make the connection at national level between the auto and oil representatives. This work may need to be done on a country-by-country or on a regional basis and it may be opportune to consider the main markets where in-field problems might occur.

8.3 Implement immediate remedies through Member State actions:

If a fuel-related problem develops quickly, it is most frequently associated with fuel that has been manufactured at a specific facility and delivered to a known marketing region through a certain terminal or via a specific pipeline. As such, a volatility-related fuel performance problem could fall into this category if a number of vehicles or specific vehicle makes and models encounter starting or driveability problems within that region over a similar period of time.

In this case, a local and immediate response is best involving a coordinated effort between the vehicle manufacturers/national association and oil suppliers/national association: the objective is to quickly fix the problem while gathering enough information to implement longer-term solutions. To deal with the immediate problem and quickly mitigate its effects, a multi-stakeholder expert team should be formed from the affected companies at a local level with the mandate to identify the source of the problem and implement quick solutions. Because not all problems and solutions can be anticipated in advance, it is recommended that the WG 21 Volatility Task Force be instructed to develop a generic rapid response plan.

Once this response plan has been developed, it can then be communicated to all appropriate companies or associations who might be affected by future fuel-related problems and have an interest in receiving technical support and a rapid response. Although each country and each situation will require slightly different approaches, rapid response actions can be expected to have some generic features:

a) A team of technical experts having particular skills and representing the major affected companies or industries with access to public relations facilities;

b) Clearly defined roles, responsibilities, and communication within the team and between the team and external contacts;

c) Access to adequate sample collection and forensic analysis of fuels from affected vehicles, service stations, and terminal locations; and

d) A documented analysis, after the problem has been resolved, describing how the problem developed, what responses were taken to mitigate the problem, and what actions would improve future response. Importantly, this analysis should be sufficient to inform all relevant bodies for potential follow-up actions, including communicating the findings and recommended actions to CEN/TC 19 and other interested stakeholders.

This plan could be produced in a reasonably short time, preferably less than six months.

Data collected to support a local and immediate response would activate an NSB notification to CEN/TC 19 that of a change in EN 228 should be considered.

8.4 Revise the EN 228 specification through a CEN/TC 19 amendment:

On the basis that an NSB requests CEN/TC 19 to consider a change to EN 228, CEN/TC 19 would instruct WG 21 to prepare the change through an investigation of the source of the in-field problem and analysis of supporting data. The WG 21 Volatility Task Force should remain active to support that request and make a proposal to WG 21 to revert back to the EN 228:2008 volatility as appropriate.

Depending upon the nature of the required change, this can be done by the Unique Approval Process (UAP) and details on a UAP amendment process are included in Annex A.

8.5 Conduct joint research to anticipate future fuel-related problems

It can be expected that engines, fuel systems, and after treatment technology will continue to evolve in order to meet future requirements. All stakeholders have a mutual interest in working together to conduct joint research aimed at identifying vehicle and fuel quality sensitivities and to develop new lab and engine test methods in order to anticipate future problems.

9 Glossary

ACEA	European Automobile Manufacturers' Association
AFR	Air-Fuel Ratio
CEN	European Committee for Standardisation
CWD	Cold Weather Driveability
DI	Driveability Index or Indices
DVPE	Dry Vapour Pressure Equivalent
E10	10 % ethanol (by volume)
E70	Percentage of sample that evaporates at 70 °C
E100	Percentage of sample that evaporates at 100 °C
E150	Percentage of sample that evaporates at 150 °C
EN	European Norm
ETBE	Ethyl Tertiary Butyl Ether
EtOH	Ethanol
EUCAR	European Council for Automotive R&D
EUDC	Extra Urban Driving Cycle
FQD	Fuel Quality Directive (2009/30/EC)
GFC	Groupement Français de Coordination
HWD	Hot Weather Driveability
IBP	Initial Boiling Point
MTBE	Methyl Tertiary Butyl Ether
NEDC	New European Driving Cycle
NSB	National Standardisation Body
RED	Renewable Energy Directive (2009/28/EC)
V/V	Volume/volume (volume fraction)
VLI	Vapour Lock Index

Annex A
(informative)

Procedure for EN 228 revision

A.1 Scope

This procedure describes the background, procedural steps, and actions needed to quickly revise the volatility parameters in the EN 228 standard (*Automotive fuels — Unleaded petrol — Requirements and test methods*) on a European and local level.

A.2 CEN/TC 19 Background

The revision of EN 228:2008 [1] was initiated at the CEN/TC 19 Plenary Meeting in Istanbul, Turkey (May 2009). This revision was meant to reflect the changes brought by the newly published (at the time) Fuels Quality Directive 2009/30/EC **.**. These changes presented some challenges both in terms of test developments (e.g. the determination of manganese content) and the request to adapt some requirements, notably volatility parameters (e.g. distillation parameters E70/E100) due to the increase in maximum allowed ethanol concentration in unleaded petrol (E10)).

At the very early stages of the revision process, it became apparent that the potential revision of the volatility parameters would be a major hurdle to overcome because different views were expressed by different stakeholders on the volatility specifications. To help resolve this problem, two key stakeholders volunteered to run engine test programmes to assess the impact of volatility on vehicle performance, emissions and drivability. A third vehicle programme, funded by the EC was also set up. To steward these programmes and draw conclusions from the data generated by all three programmes, a Volatility Task Force (VTF) was also established.

Based on the outcome of these activities, a compromise was reached at the February 2012 WG 21 meeting and the volatility parameters (E70, E100, and VLI) have been adapted. This was accepted under the condition that a mechanism would be put in place to return the volatility parameters to their previous values if volatility-related field problems warranted such a change. If this were to occur, the shortest possible amendment process according to CEN procedures would need to be followed. The VTF was also asked to prepare procedures for local immediate action and for judging the market data gathered.

A.3 Background to CEN Procedures

The CEN Technical Board has decided on several actions to speed up the development of European Standards. Regardless of the methods of evaluation used in the process, the final objective is to ensure that there is consensus of all interested parties concerned on the resulting EN specification. This is especially important when adopting a Unique Acceptance Procedure (UAP) since no technical modifications to the text are allowed between the vote and the publication of the revised specification.

The CEN/CENELEC Internal Rules[3] allow a single ballot procedure, called the Unique Acceptance Procedure (UAP) that combines the CEN Enquiry and Formal Vote into one step. This UAP should only be used in order to prevent delays and if it is reasonable to assume that the document will be accepted at the European level. For an amendment to an existing EN specification, the CEN/TC can decide to shorten the period of the UAP to just three months. This is only possible on condition that the draft amendment is simple, not controversial, and no CEN National Member makes a substantiated objection.

[3] http://www.cen.eu/boss/supporting/Reference%20documents/Internalregulations/Pages/default.aspx

The procedure and timeframe are then as follows:

1) The TC secretary sends the draft revision via E-Trans in the relevant reference language to CCMC[4] for processing (week 0);

2) CCMC allocates a reference number, carries out the relevant administrative tasks and edits the reference language version of the FprEN (week 3);

3) CCMC finalizes the reference language version of the FprEN, after agreement on any modifications has been reached with the TC Secretary, and sends the documents to the relevant National Standards Bodies (NSBs) for translation of the remaining 2 official CEN language versions (week 5);

4) The relevant NSBs prepare the translations and return them to CCMC, normally within 8 weeks (week 13);

5) On receipt of the translations, CCMC dispatches the draft document in the available language versions (week 14);

6) The CEN National Members submit their vote and their comments within the prescribed 3-month period (week 27);

7) One day after the deadline of the UAP vote, CCMC completes the voting report, compiles the comments and dispatches both the voting report and the comments (week 27);

8) If the vote is affirmative[5], CCMC (in consultation with the TC Secretary) incorporates the editorial changes[6] (week 28);

9) CCMC sends the reference language version for translation (week 31). Exactly one month after the conclusion of the ballot, the standard text is considered to be ratified (dor = date of ratification);

10) The NSBs prepare the translations and return them to CCMC (week 35);

11) CCMC distributes the definitive text of the approved European Standard (EN) in the available language version(s) (dav = date of availability, week 36);

12) The CEN National Member announces the existence of the revised EN at national level within the defined timeframe (doa = date of announcement, equals dav + 3 months, week 49).

13) The CEN National Member implements the revised EN at national level with the national Annex (dop – date of publication, equals dav + 6 months), and withdraws the previous EN (dow – date of withdrawal, normally equals dav + 6 months) (week 62).

A.4 The EN 228 amendment procedure as it applies to volatility specifications

Essentially, the amendment concerns a change in some specific figures in Table 4 of EN 228:2012. For this reason, the amendment text can be prepared and the decision by CEN/TC 19 can be handled in advance. By accepting this procedure, CEN/TC 19 adopts a Preliminary Work Item (PWI) for EN 228 on a shortened UAP in order to amend Table 4. CEN/TC 19 also delegates the decision to activate this PWI to WG 21 and the TC Secretariat.

On request of WG 21, the CEN/TC 19 Secretary can activate the PWI and submit the already prepared amendment text. CCMC can be requested (but is not required) to shorten Steps 2 and 3 of the above schedule. In order to speed up translation, the CEN/TC 19 Secretary can also supply the French and German translations (prepared in consultation with BNPé and DIN-FAM).

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[4] CEN/CENELEC Management Centre in Brussels

[5] UAP is a weighted vote, meaning 71 % approval from all votes excluding abstentions.

[6] During the voting period, CCMC will not take into account comments that are received requesting an alteration of the technical content of the FprEN. No technical changes shall be made to the text following a positive approval procedure. The TC shall take into account any technical comments for a future amendment or revision of the text.

The ballot period is no less than 3 months. The amendment of Table 4 has no impact on the climatic choices of the CEN National Member, meaning that technical comments during the ballot and changes to the national annex are not expected. This suggests that the above time frame up to Step 10 can be shortened. The CEN/TC 19 Secretary and CCMC should contact each other on this when appropriate. Steps 12 and 13 are the responsibilities of National Members. When informed and prepared in advance, an amendment concerning the national adoption of EN 228:2012 can be implemented instantly if the national mirror committees insists on this.

A shortened UAP ballot, prepared ahead by available translations, with constant follow-up by the TC Secretary and CCMC and good preparation at national level, may lead to national adoption of the revised EN 228 within half a year after the need for an amendment has been agreed upon by WG 21.

A.5 National intermediate adaptation procedure

National Members may revise their informative national annexes and thus their national adoption of EN 228. They shall however not contradict the technical requirements in the main text. The figures in Table 4 can thus not be adopted, but an informative annex can provide information on the issues that have been found by CEN/TC 19 and the most likely outcome. By revising their national annex, national mirror committees may guide the market towards revised volatility requirements. However, in every country the impact and acceptance of such guidance may be different.

Annex B
(informative)

Summary of OEM test programs - EN 228 high volatility robustness

B.1 Background

In order to help evaluate the changes to $E70_{min}$, $E70_{max}$ and $E100_{max}$ proposed by CONCAWE, four vehicle manufacturers undertook and funded individual test programs on a range of representative vehicles and fuels:

	Daimler	**Ford**	**PSA**	**Renault**
Test vehicle 1	M276 DE 35 DI stratified	1.6 PFI NA	1.6 PFI NA	1.6 MPI NA
Test vehicle 2	M278 DE 46 DI turbo	1.6 DI turbo	1.6 DI turbo	2.0 MPI turbo
Test vehicle 3	M272 KE PFI (evap tests only)	-	-	-
Test fuels:				
CEC-RF-02-08 (E5)		□	□	
OEM in-house reference gasoline			□	□
E5-A summer baseline	□			
E5-E winter baseline	□			
E10-E winter baseline		□		□
E10-A summer Step1			□	□
E10-E winter Step1			□	□
E10-A summer Step2	□			
E10-E winter Step2	□	□		
E10-A ref (Cal clean fuel)	□			

Step 1 means $E70_{max}$ relaxed by +4 % and $E100_{max}$ relaxed by +2 %.

Step 2 means $E70_{max}$ relaxed by +10 % and $E100_{max}$ relaxed by +4 %.

All fuels were provided via CONCAWE.

The test vehicles, fuels and tests conducted were at the choice of each individual vehicle manufacturer.

B.2 Mercedes-Benz tests summary

Mercedes-Benz decided to evaluate Step 2 fuels.

Exhaust emissions during -7 °C cold start (Type 6) test;

- All emission results were within the limits for the regulated pollutants CO and HC for vehicles 1 and 2.

Exhaust emission during the normal emission (Type 1) test:

- All emission results were within the limits for the regulated pollutants CO and NMHC, THC and NOx for vehicle 1.

- For vehicle 2, the CO measured using E10-E winter Step 2 fuel **exceeded the legal limit**. The same vehicle and its settings was tested again on the same E10-E winter Step 2 fuel 4 weeks later and the CO measured was then within the legal limit. The reason is unclear but could be due to fuel degradation over the 4-week period that reduced the E70 by about 3 % vol.

Evaporative emissions over FTP75 (running loss and carbon canister loading):

- Vehicle 3 showed a small increase in carbon canister loading using E10-A summer Step 2 fuel.

- Vehicle 2 showed **an increase** of about 6 g in carbon canister loading using E10-A summer Step 2 fuel. The higher volatility of winter Step 2 fuel would result in a far higher carbon canister loading. It could be expected that this would have a negative impact on fuel economy for stratified direct injection engine technology.

Evaporative emissions (SHED test):

- The measured evaporative emissions were below the present limit of 2g/test. However, with the likelihood that a new and longer evaporative emission test (but the same limit) will come into Euro 6, **the effect on evaporative emissions of the tested fuels needs further evaluation**.

Cold start (-25 °C) tests:

- Vehicle 1 showed no problems using E10-A Step 2 and E10-E Step 2 fuels during the cold start tests according to the Mercedes-Benz validation criteria.

- Vehicle 2 showed no problems using E5E winter ref, E10-A summer Step 2 and E10-E winter Step 2 fuels during the cold start tests according to the Mercedes-Benz validation criteria.

Hot driveability (40* °C) *tests:

- Vehicle 2 (plastic fuel tank) showed no problems using E10-A summer and E10-E winter Step 2 fuels when tested over the three Mercedes-Benz hot driveability procedures.

- However, vehicle 1 (metal fuel tank) showed **problems with engine stalling** when using E10-A summer Step 2 fuel after 90 min during the hot start test followed by 120 min of engine idling. Vehicle 1 showed **problems with engine stalling** after only 25 s when using E10-E winter Step 2 fuel during the same test. Vehicle 1 showed **problems with engine stalling** after only 25 s when using E10-E winter Step 2 fuel during the hot start test followed by full load acceleration. The cause of these problems was due to loss of pressure in the low- or high-pressure fuel pump/delivery system resulting in ‘vapour lock’. Fuel odour was also recorded during these tests at a level that would be unacceptable for the customer.

The negative results of the Mercedes-Benz tests can be summarised as follows:

- Hot weather driveability using E10-A summer Step 2 fuel did not meet the Mercedes-Benz validation criteria.

- CO emissions during Type 1 test above the legal limit using E10-E winter Step 2 fuel.

- Hot weather driveability using E10-E winter Step 2 fuel did not meet the Mercedes-Benz validation criteria.

- Further evaluation of the effect on evaporative emissions is recommended.

The fuels evaluated are not accepted for Mercedes-Benz cars.

B.3 Ford tests summary

Ford decided to evaluate Step 2 fuels during current development programs due to constraints on test facility availability and timing.

Exhaust emissions during -7 °C cold start (Type 6) test:

- All emission results were within the limits for the regulated pollutants CO and HC for vehicles 1 and 2.

Exhaust emission during the normal emission (Type 1) test:

- All emission results were within the limits for the regulated pollutants for vehicle 1 and 2.

Cold start tests:

- Vehicle 1 showed **enrichening effects** using E10-E winter Step 2 fuel during cold start/idle tests at -20 °C and -7 °C. Vehicle 1 also showed **significant changes in lambda** using E10-E winter Step 2 during cold start/NEDC tests at -20 °C, -7 °C and +20 °C.

- Vehicle 2 showed **significantly richer operation** for 160 s using E10-E winter Step 2 fuel during the cold start/idle test at -20 °C.

- Vehicle 2 also showed **significantly richer operation** for 40 s using E10-E winter Step 2 fuel during the cold start/NEDC test at -7 °C.

- Vehicle 2 exhibited **engine roughness with a higher level of engine misfire counts** using E10-E winter Step 2 fuel during the cold start/idle test at -7 °C. Vehicle 2 also exhibited **engine roughness with a higher level of engine misfire counts** using E10-E winter Step 2 fuel during the cold start/NEDC test at -7 °C.

The negative results of the Ford tests can be summarised as follows:

- Richer operation observed during cold start tests using E10-E winter Step 2 fuel.

- Higher levels of engine misfire and engine roughness during cold start tests using E10-E winter Step 2 fuel.

The fuels evaluated are not accepted for Ford cars.

B.4 PSA tests summary

PSA decided to evaluate Step 1 fuels.

Start-up timing:

- No degradation in start-up timing at -20 °C and +20 °C was observed for vehicles 1 and 2 using E10-A summer and E10-E Step 1 fuels.

Cold start (-20 °C) tests running NEDC:

- The E10-A summer and E10-E winter Step 1 fuels showed **enriching effects** on both vehicles 1 and 2 up to 6000TDC, **far exceeding the normal lambda control point**. This poses a **high risk** of plugging of the spark plugs and a consequential effect on lube-oil dilution.

Cold start (+20 °C) tests running NEDC:

- The E10-A summer and E10-E winter Step 1 fuels showed **enriching effects** on both vehicles 1 and 2 up to 750TDC. While this showed no negative effects on engine behaviour or driveability, it poses **risk** of plugging of the spark plugs, a consequential effect on lube-oil dilution and also higher CO emissions.

Exhaust emission during the normal emission (Type 1) test:

- Measurements of CO2, NMHC, THC and NOx showed no significant differences using E10-A summer and E10-E winter Step 1 fuels.

- However, **CO emissions were highly elevated** using E10-A summer and E10-E winter Step 1 fuels. While the legal limit for CO was not exceeded, the limit shall be met over 160,000 km durability so any increase in CO over the PSA engineering target is a concern.

The negative results of the PSA tests can be summarised as follows:

- Highly elevated emissions of CO compared to the certified values for the vehicles tested.

- Enriching effects during cold starting risking plugging of the spark plug – higher risk for vehicle 1 equipped with the PFI engine. Consequential risk of lube-oil dilution.

The fuels evaluated are not accepted for PSA cars.

B.5 Renault tests summary

Renault decided to evaluate Step 1 fuels.

Hot start tests:

- Over a Renault test procedure at +30 °C, vehicle 1 showed **unacceptable start-up time and engine speed pick-up** using E10-E winter Step 1 fuel. Over the same test, vehicle 1 achieved the Renault validation criteria using E10-A summer Step 1 fuel.

- Vehicle 2 achieved most of the Renault validation criteria using E10-E winter Step 1 fuel. However, vehicle 2 did not meet the Renault validation criteria after 10 min of one test due to a **significant lack of richness** that resulted in an unstable engine speed.

Cold start tests:

- Over a Renault test procedure at -20 °C and 0 °C, vehicle 1 exhibited **too rich operation with unstable engine speed** using E10-E winter Step 1 fuel. Over the same tests, vehicle 1 achieved the Renault validation criteria using E10-A summer Step 1 fuel.

- During the cold start test at -20 °C using E10-E winter Step 1 fuel, vehicle 2 exhibited an **extended engine start time followed by a large undershoot of the lambda control** with consequential unstable engine speed resulting in rough engine running. This did not meet the Renault validation criteria.

- During the cold start test at 0 °C using E10-E winter Step 1 fuel, vehicle 2 exhibited a **large undershoot of the lambda control with consequential unstable engine speed** resulting in rough and hesitant engine running. This did not meet the Renault validation criteria.

- Vehicle 2 met the Renault validation criteria during the cold start tests using E10-A summer Step 1 fuel.

The negative results of the Renault tests can be summarised as follows:

- Hot start tests using E10-E winter Step 1 fuel do not meet the Renault validation criteria.

- Cold start tests using E10-E winter Step 1 fuel do not meet the Renault validation criteria.

The fuels evaluated are not accepted for Renault cars.

Bibliography

[1] EN 228:2008, *Automotive fuels – Unleaded petrol – Requirements and test methods*

[2] *Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC,* Official Journal of the European Communities No. L140, 05.06.2009

[3] *Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC*

[4] *Ethanol/petrol blends: volatility characterisation in the range 5-25 vol% ethanol.* TREN/D2/454-2008-SI.2.522.698 (Final Report). Brussels: EU Commission http://ec.europa.eu/energy/renewables/studies/renewables_en.htm, 2010

[5] *Volatility and vehicle driveability performance of ethanol/gasoline blends: a literature review,* Report No. 8/09, Brussels: CONCAWE, 2012

[6] *Gasoline volatility and vehicle performance,* Report No. 2/12, Brussels,: CONCAWE, 2012

[7] *Summary of OEM test programs – EN 228 high volatility robustness,* CEN/TC 19/WG 21/N 255, ACEA (2012)

[8] *Programme on petrol blending effects regarding E10,* Project LM11082, Applus IDIADA, 2012

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