

## Ethanol Blended Gasoline – E 85 Fuel Quality Standard

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UTILITY REGULATION AND COMPETITION OFFICE  
THE CAYMAN ISLANDS



(2A) Ethanol Blended Gasoline - E85

- (a) E85 refers to ethanol-blended gasoline containing 51 to 83 percent of ethanol (as volume) blended into gasoline and it is typically sold for the flexible fuel vehicles (FFV) market. It is considered as an alternative fuel and the Cayman Islands' National Energy Policy (NEP) has identified alternative fuels as one which shall be promoted to reduce harmful emissions.
- (b) With E85 there is a seasonal and geographical volatility to be considered when blending ethanol with gasoline. ASTM has identified four (4) different volatility classes and based on their criteria; the Cayman Islands is categorized as a class 1 region where the ethanol content in gasoline must range between 70 to 83 percent of ethanol in volume.
- (c) Please see Appendix [1] for OfReg's additional requirements in relation to E85.

Parameter	Specification	Testing Method
Acidity – as acetic acid	0.005% m/m maximum	ASTM D7795
*Benzene	0.35% v/v maximum	ASTM D5580
Copper	0.07 mg/L maximum	ASTM D1688
^Distillation–final boiling point	225°C maximum	ASTM D86
*Ethanol – ASTM Volati Class - 1	70 – 85%% v/v	ASTM 6839
*Lead	2.5mg/L minimum to 25mg/L maximum	ASTM D3237
Methanol	0.5% v/v maximum	ASTM D5501
Motor Octane number (MON)	87 minimum	(see note)
^Oxidation Stability	240 minutes minimum	ASTM D525
pHe	6.5 – 9.0	ASTM D6423



Parameter	Specification	Testing Method
Inorganic chloride	1.0mg/Kg maximum	ASTM D7319 or D7328
Research octane numb (RON)	100 minimum	(see note)
Solvent washed gum	5.0mg/100 mL maximum	ASTM D381
Unwashed gum	20.0mg/100mL	ASTM D381
Sulfur	80.0 mg/Kg maximum	ASTM D5453 or D7328
Vapour pressure – AST Volatility Class - 1	38-62 kPa (5.5 -9.0 psi)	ASTM D5191

\*Australia Fuel Quality Standards (Ethanol E85) Determination 2019

^ASTM D5798 -21 Table 2: Requirements for Hydrocarbon blendstock

Note: Testing methods for determining the MON and RON of E85 are not yet available. The minimum targets specified in the table are interim targets until a testing method is available. These minimum targets allow for engine calibration.

**APPENDIX [1]****Ethanol 85 (E85) Standards Cont.**

<b>Table 1: Properties of Fuel Ethanol and E85</b>	
<b>Property</b>	<b>Comment</b>
Vapor Density	Ethanol vapor, like gasoline vapor, is denser than air and tends to settle in low areas. Ethanol/gasoline blends, including E85, should be treated like gasoline blends with respect to handling and safety.
Solubility in Water	Ethanol is extremely hygroscopic (i.e., attracts water). Water should be removed to the extent possible from fuel ethanol handling, storage, and distribution equipment. A small amount of water is soluble in E85, but at higher concentrations, the gasoline portion will separate from the ethanol/water mixture.
Energy Content	For identical volumes, ethanol contains approximately 30% less energy than gasoline, depending on the gasoline formulation. As a result, vehicle fuel economy of E85 can be expected to be reduced by about 25%, depending on the gasoline formulation and the individual vehicle.
Flame Visibility	A fuel ethanol flame is less bright than a gasoline flame but is easily visible in daylight.
Specific Gravity	Pure ethanol and ethanol/gasoline blends are slightly denser than gasoline
Conductivity	Ethanol and ethanol blends have increased electrical conductivity compared to gasoline. This can affect materials compatibility due to increased corrosion of certain metal junctions and exposed electrical connections.
Air-Fuel Ratio	Due to the oxygen content in ethanol, the ideal or “stoichiometric” air-fuel ratio for E85 is a lower value than it is for gasoline (i.e., fewer pounds of air per pound of fuel). FFVs are designed to detect ethanol and properly adjust the air-fuel ratio.
Toxicity	Pure ethanol in small amounts is not toxic and is not considered carcinogenic; however, fuel ethanol and ethanol/gasoline blends must be treated as toxic and carcinogenic due to the addition of hydrocarbons and gasoline.
Flammability	Depending on the hydrocarbon blending component, the vapor concentration in the storage tank head space of many E85 blends can fall into the flammable range. This is a concern primarily at low ambient temperatures.

<b>Table 2: Fuel Properties of Ethanol, Gasoline and E85</b>			
<b>Property</b>	<b>Ethanol</b>	<b>Gasoline</b>	<b>E85*</b>
Chemical Formula	C <sub>2</sub> H <sub>5</sub> OH	C <sub>4</sub> to C <sub>12</sub> Hydrocarbons	C <sub>4</sub> to C <sub>12</sub> Hydrocarbons and Oxygenated Hydrocarbons
Main Constituents (% by Weight)	52 C, 13 H, 35 O	85-88 C, 12 – 15 H	57 C, 13H, 30 O
Octane (R+M)/2	113	86-94	95 - 97
Lower Heating Value (Btu per gallon)	76,300	116,900	83,600 – 95,450
Miles per Gallon Relative to Gasoline	67%	-	73%**
Reid Vapor Pressure (psi)	2.3	7-16	7-12
Ignition Point-Fuel in Air (%) Temperature (approx.) (*F)	3-19 850	1-8 495	Varies Varies
Specific Gravity (60*/65*F)	0.794	0.72-).78	0.78
Air Fuel Ratio (by Weight)	9	14.7	10
	3.0	1.85	2.75 – 2.95

\*Depends on hydrocarbon blending component properties. \*\*Depends on both vehicle model and percentage ethanol in fuel

### **ASTM Volatility Class:**

The ethanol content of E85 is seasonally adjusted to improve cold start and warm-up performance. The volatility classes for E85 are detailed by ASTM D5798 where vapour pressure can vary depending on seasonal and climatic changes. The volatility classes are as follows:

Class 1 – Encompasses geographical areas with six (6) hour tenth percentile minimum ambient temperature of greater than 5°C (41°F)

Class 2 – Encompasses geographical areas with six (6) hour tenth percentile minimum ambient temperature of greater than -5°C (23°F) but less than or equal to 5°C (41°F).

Class 3 – Encompasses geographical areas with six (6) hour tenth percentile minimum ambient temperature greater than -13°C (9°F) but less than -5°C (23°F).

Class 4 – Encompasses geographical area with six (6) hour tenth percentile minimum ambient temperature less than or equal to -13°C (9°F).

Given Cayman's geographical location and seasonal conditions where the ambient temperature range in summer is between 24 to 32°C and during winter between 22 to 30°C, the ASTM volatility class for ethanol blends in this range falls under class 1. The

acceptable associated vapour pressure in class 1 is between 5.5 and 9.0 psi when using either test method ASTM D4953 or D5191.

Table 3 details the relationship between the volatility classes and their vapour pressure. Given that gasoline and ethanol are volatile substances and that high vapour pressures indicate a high volatility; then with the class 1 E85 blend, engines performance is not affected at the lower vapour pressure with the higher percentage ethanol blends. This vapour pressure is measured as dry vapour pressure equivalent and it varies among classes due to driveability requirements as ambient temperatures changes. Driveability is the degree of smoothness and steadiness of acceleration of an automotive vehicle. Therefore, E85 ethanol to gasoline ratio must produce a vapour pressure between 5.5 and 9.0 for FFV to have good driveability at ambient temperatures.

Property	Value of Class			
ASTM Volatility Class	1	2	3	4
Vapour Pressure (psi)	5.5 – 9.0	7.0 – 9.5	8.5 - 12	9.5 – 15.0

According to the National Renewable Energy Laboratory (NREL) of the US Department of Energy, a national 2010-2011 survey of E85, the percentage of ethanol content for E85 tends to have an inverse relationship to vapour pressures; so where the vapour pressure is low, the ethanol content is high. In the Cayman Islands, a class 1 region, the percentage of ethanol in the blend will be expected to be higher and from the NREL survey the average ethanol blend from the samples tested for class 1 areas is 80%.

### **Storage and Handling Management:**

This section of the standard considers the impact of E85 on materials used for the storing and handling of E85. Focus is placed on the critical set of equipment involved and not all the components found at a retail station.

Research has indicated that materials commonly used with gasoline may be incompatible for high concentrate ethanol blends. *“Blends below E25 do not cause corrosion of metals (unless accompanied by a separate aqueous phase).”* Given that E85 is a higher blend careful consideration must be given to the materials used with the storage and handling. *E85 acts like a cleaning agent and will initially mobilize sludge in storage tanks. “E85 can also cause corrosion of some soft metals and reduce the tensile strength of some nonmetallic materials. Zinc, brass, lead, and aluminum have shown sensitivity to degradation with E85. Terne-plated steel (lead-tin alloy coating), which has been commonly used for vehicle fuel tanks, and lead-based solder are also incompatible with E85. Use of these metals should be avoided. Unplated steel, stainless steel, black iron, and bronze have shown acceptable resistance to E85 corrosion.”*

The storage and handling requirements insist that equipment handling and storing ethanol blended gasoline E85 must be UL listed and E85 compatible. These requirements diminish the risk of material failure and help to ensure proper function where E85 fuel is in direct contact with these components.

### **Underground Storage Tanks (USTs)**

A person must demonstrate that the construction materials of the USTs are compatible for E85 by one of the following options:

- (1) An internationally recognized, independent testing laboratory certification or listing for the equipment used for the fuel stored; or
- (2) Approval from the equipment or component manufacturer for use with the fuel stored. This statement affirming compatibility must be in writing and list the specific ranges of biofuel blends with which the equipment or component is compatible.

A person must colour code and label the E85 tank's covers clearly identifying and distinguishing this tank from the other tanks. The recognized colour for E85 is yellow with E85 stencil in black and positioned in the center of the covers.

It is difficult to anticipate the frequency at which E85 will be replenished in their storage tanks and as such there are some operational precautions as advised by the US Department of Energy to assure fuel quality. They recommended the following items to be checked every one or two months depending on how frequently the fuel is used.

- I. Particulate content – Samples are taken from the top, middle, and bottom of the tank. If present, water and particulates will show in the bottom sample. The middle sample will specify the degree of settlement of any contaminants and the top will indicate what can be achieved if the fuel is to be polished.
- II. Electrical conductivity – Sample taken from the tank and tested using an approved conductivity instrument in conformity to test method ASTM D2624.
- III. Reid vapour pressure – The specimen is placed in a test chamber and allowed to reach thermal equilibrium at the test temperature, 37.8°C (100°F), and the pressure is measured using a pressure transducer sensor and indicator.
- IV. Hydrocarbon content – Analysis can be undertaken using high-resolution gas chromatography.
- V. Water content - Not all water detection pastes are effective in the presence of EtOH. Advice should be sought from the manufacturer or supplier that the paste is appropriate for alcohol blend fuels. If water, or a water/EtOH phase, is found to be present at the bottom of a tank, it should be pumped out immediately. Care should be taken with this water, or water/EtOH as it may be flammable and toxic. It is recommended that gas in your vehicle fuel tank should be replaced every 2 to 3 weeks to avoid alcohol and water-related engine problems.



Given the above, in the event of questionable fuel quality, there are no facilities in the Cayman Islands to test and verify the quality of E85. Therefore, samples will be exported to verify quality at the operator's expense.

### **Pipes**

All pipes must be compatible with the UL 971 "Standard for Safety Nonmetallic Underground Piping for Flammable Liquids" and the manufacturer's listing must indicate ethanol blends up to E100. These pipes must have a primary and secondary containment and terminate inside sumps which must also be compatible with E85.

### **Submersible Turbine Pump (STP)**

STP must be UL-listed and compatible with E85.

### **Dispenser & Associated Accessories**

Labeling for identification of tanks and dispensers is an operational requirement to ensure there is no comingling either in the storage tanks or vehicles' tanks. This is to avoid the very expensive procedures of purging and cleaning the tanks and engine components and engine performance.

The dispenser and the accessories, such as shear valves, breakaways, swivels, nozzles, and hoses must be UL-listed and compatible with E85. The dispenser must be fitted with filters of a nominal rating of 50% for particles 5 microns or larger or 99% for particles 10 microns or larger.

Retail Dispenser Labelling. – All retail dispensing devices must identify conspicuously the type of product, the grade of the product, and the applicable automotive fuel rating. This label must follow the US Department of Energy labeling requirement and the nozzle boot must also be yellow.

Dispenser Nozzle Size – Diameter = 13/16"

### **Fuel Quality Management:**

Fuel quality management must be considered from two perspectives which are "offshore and onshore" where offshore will identify the parameters, specifications and testing methods to ensure there is a standard quality E85 blended gasoline imported on a consistent basis. Onshore will address operational procedures by an operator at their facility to maintain the quality of fuel while being stored and distributed from their retail and/or bulk storage outlets.

The final determination of the E85 Fuel Quality Standards can be located at

<https://www.ofreg.ky/consultations/fs-2023-2-final-determination-e85-fuels-quality-standards>