

FS 2023-2 Final Determination E85 Fuels Quality  
Standards

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**UTILITY REGULATION AND COMPETITION OFFICE  
THE CAYMAN ISLANDS**

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## A. Introduction

1. The Utility Regulation and Competition Office ('OfReg', or the 'Office') is the independent multi-sector regulator, with responsibility for the key utilities providers in the Cayman Islands, including the fuel sector ('Fuel Sector'), in addition to the electricity, information and communications technology ('ICT'), water, and wastewater sectors.
2. Different decisions by the Office will affect persons and organisations throughout the country in different ways. It is therefore important that the Office make regulatory decisions and propose new regulations with the appropriate input from persons with sufficient interest, or who are likely to be affected by the outcome of such decisions. Consultation is an essential aspect of regulatory accountability and transparency, and provides the formal mechanism for these persons to express their views in this manner. The requirement for the Office to consult is mandated in its enabling legislation.
3. Under its enabling and foundational legislation, the Office has several principal mandates. One of these principal mandates is to assure competition, transparency, efficiency and innovation in the Fuel Sector, along with its continuing function of ensuring safety and compliance across the Fuel Sector. The Office may do so by making administrative determinations, decisions, orders and regulations.
4. In order for the Office to effectively and efficiently carry out its duties regarding its regulatory remit, more specifically environmental safety, transparency, and product quality assurance; the Office sees it necessary to submit a standard for ethanol blended gasoline E85 type ("E85") to guide importers, distributors and consumers with a standard for importation, storage, handling and distribution.
5. On 11 December 2023, the Office invited relevant fuel sector players to participate in the FS 2023 – 2 – Consultation Ethanol Blended Gasoline E85 Importation and Consumption.
6. The consultation period closed for submissions at 5:00 pm on 02 January 2024.
7. As at the close of the consultation period the Office received two responses from fourteen sectoral representatives that were asked to participate in the FS 2023 – 2 – Consultation Ethanol Blended Gasoline E85 Importation and Consumption.
8. In this document, the Office addresses the issues raised in the consultation process regarding the E85 standard.



## **B. Legal Framework**

The Office is guided by its statutory remit to ensure there are standards for fuels imported into the Cayman Islands.

9. The Utility Regulation and Competition Act (2021 Revision) (the 'URC Act') is the principal legislation governing the Office's mandate with respect to the Fuel Sector. Alongside the URC Act, the sector-specific legislations governing the Fuel Sector are the Dangerous Substances Act (2022 Revision) (the 'DS Act') and its supporting Regulations ('DSR'), and the Fuel Market Regulation Act (2017) (the 'FMR Act').

10. Regulation 31 of the DSR:

9. Section 9A (1) of the DS Act:

10. Section 9A (3) of the DS Act:

11. Section 9A (4) of the DS Act:

12. Section 9B of the DS Act:

13. Section 9(D) of the DS Act:

These sections of the act and regulations are reproduced in appendix 2 of this determination.



## C. FS 2023 – 2 – Consultation

14. In the closed **FS 2023 - 2 - Consultation**, the Office considered that it is in the interests of the relevant fuel sector players to provide their feedback regarding ethanol blended gasoline E85 importation and consumption, in order for the Office to effectively and efficiently carry out its duties regarding its regulatory remit, to monitor fuel quality.
15. In the Consultation, the Office posed five specific questions regarding ethanol blended gasoline E85 importation, consumption, storage and handling.

Question 1:

What are your views on E85 fuel, and are there any concerns of adding this fuel to the fuel mix of the Cayman Islands?

Question 2:

Please review the E85 thoroughly and provide any feedback, concerns or questions you may have, as it relates to the various parameters of each specification and testing methods.

Question 3:

Are there any other critical storage and handling equipment which must be compatible with E85, labelled and identify for E85 only?

Question 4:

Should there be a pump attendant at the nozzle alerting consumers to the E85?  
Should consumer be responsible for labelling their tank nozzle to alert pump attendants of their vehicle compatibility to E85?

Question 5:

What is the suggested colour to identify E85 fuel on the storage tank, pump nozzle, consumer's fuel tank?



## D. Comments Received and Office Responses

16. The Office received two responses to **FS 2023 - 2 - Consultation**, which were from Refuel and Foster Group. The Office has reviewed all comments received, and its responses are set out below.

### i) Foster Group General Response

17. Apologies for the late response. I was hoping to get support information from some OEMs but due to the Christmas holidays, I have had a poor response. I will follow up and try to forward an opinion on E85 for vehicles being imported for the brands that Car City represents.

18. After reading the draft, I support the addition of E85 as outlined in the draft document.

Office response

19. The Office noted Foster Group's response.

### ii) Refuel

#### Question 1:

***What are your views on E85 fuel, and are there any concerns of adding this fuel to the fuel mix of the Cayman Islands?***

20. We have no concerns because this product was successfully added to the Cayman Market without any reported complaints many years ago. It is not a new product to Cayman. It has been available in the Cayman Islands' market for at least the last 5 years with what appears to be many hundreds to potentially thousands of gallons being imported monthly, and has had no negative reported impact. We hope that any policies discussed will be an extension of the existing policies the Office (OfReg) is using to regulate the market segment and that they will be applied consistently and proportionately across all players. The draft version of Cayman's new Climate Policy 2023-2040 that was publicly released is directly aligned with the further importation and availability of this product. It states the "transport sector is the second largest contributor of both CO<sub>2</sub> and GHG emissions in the Cayman Islands" Goal 1 and 2 of the Policy are to "Reduce Cayman's vulnerability and enhance our resiliency to Climate Change" and to "Promote sustainable, low or zero carbon economic activity". Furthering the availability of this product has the potential to significantly decarbonize transportation. E85 reduces lifecycle petroleum use by 70%. Moreover the product meets our vision of lowering emissions, and lowering consumer prices, which is aligned with CIG's goal of



innovation and the same. Refuel could drastically lower the price point of the currently available E85 on the market. Lastly, E85 has been the most anticipated product at the pump Refuel has ever received feedback on. Multiple potential consumers have reached out over the years, but notably of late, requesting information on when it will be available at our location.

### **Office Response**

21. The Office supports the CIG's goal of the introduction of alternative fuels, such as E85 to the fuel mix. It lessens the dependence on finite fossils and helps in the reduction of greenhouse gases. E85 with its higher ethanol content offers a favourable alternative to conventional gasoline and it's availability increases the diversification of fuel options.

### **Question 2:**

***Please review the E85 thoroughly and provide any feedback, concerns or questions you may have, as it relates to the various parameters of each specification and testing methods.***

22. We are confident in quality but have serious concerns with the cost of the testing requirements. A credo of management is that one cannot manage what one cannot measure. If you are going to create a set of regulated standards per unit volume then the regulator needs to set up a testing facility in Cayman to test to that determined standard locally. You should be lowering barriers to entry, supporting competition, and incentivizing innovation with regard to renewable product adoption, but the potential here exists to prohibitively raise the cost of testing requirements, consumer costs, and prevent further adoption entirely. While we are confident in quality and have provided a Certificate of Analysis, (COA) to the office demonstrating as such, we are not Chevron, Exxon, Shell or any big player. We can provide what we are given, we cannot change the analysis slate, and we have significant concerns over any additional costs that would accrue over further testing in addition to the COA provided. If the Office chooses to regulate without a local facility, please take into consideration that any regulations created are compatible with the Offshore COAs we have provided or the entire viability of import may be inadvertently regulated against. The risk is present that over-regulation of E85 with regard to specifications or testing requirements that are not readily available in the US at a given time, would exclude all existing and future imports of E85 into Cayman.
23. We note your use of the Australian Standards for Ethanol content between 70-85%, and can as per our COA comply with this percentage, and agree that the maximum percentage should not be lower than 85%. We would further argue though that there should be no regulation of ethanol content between 51-85%, as the range only exists on the low end to accommodate vapor pressure adjustments, to improve cold weather start and warm up (which is an issue that does not exist



in the Cayman Islands (N.B the Office also does not regulate vapor pressure changes seasonally for Gasoline as they do in the USA for evaporative purposes)) and any reference to 83% is for the accommodation of denaturant under separate US regulations. Any volume between 51% and 85% is Flex Fuel, E85, and should be allowed.

24. In response to Onshore Testing every 60 days and section D29 of the Paper, (Committee Paper/Fuels- Ethanol Blended Gasoline E85). We are of the position that the Paper's, assumptions on the market, and turnover, to be inaccurate. Consumption rate will not present itself as a realistic issue as estimates based on publicly available vehicle registrations in the Cayman Islands, and the significant positive feedback received from customers in anticipation of the product will result in turnover many multiples faster than once every 60 days.
25. Moreover this testing requirement will not realistically present itself, because if product in the ground does turn over as slowly as the Paper assumes or as infrequently as once every 60 days then the product will not be commercially viable and we will discontinue it entirely so this requirement will never be necessitated.
26. If the Office mandates this requirement regardless of turnover then we have further concerns with the cost and infeasibility of any "onshore" testing that actually requires shipment to the US for offshore testing. We have no concern with the quality, but we agree with your CEO when he highlighted the infeasibility of any testing requirement that involves offshore shipping in a recent Compass Article; "Sometimes the quality samples got lost, some were out of time – it was taking three or four months to get the results back. Now we have our own equipment" It will take many weeks to months to receive results if samples are to be exported, by which time the fuel in question will have been sold and turned over, or if we are prevented from retail during the testing period only serve to exacerbate or create a previously non-existent issue while we wait for results. This statement again highlights the infeasibility of creating a standard that cannot be measured/tested locally and the Office's own understanding that local equipment is required to monitor standards.
27. We welcome OfReg to conduct local tests, and as we have suggested we would assist proportionally with other importers in building a facility locally to test, but given the turnover expected, it is not anticipated that there will be any necessity to export samples, nor would a stop sale be viable if such scenarios were consistently overregulated due to the above reasons.

### **Office Response**

28. All importers are required to adhere to the requirement of submitting a COA of their fuels imported as indication of the quality of fuel being imported. The Office duty is to ensure a fair and level playing field for all to prevent discrimination against, or preferential treatment of any person in the fuel sector.
29. Cayman Islands are a class 1 territory according to its seasonal and climatic conditions of the islands according to ASTM volatility classes for E85. As per the





work done by the US Department of Energy, the percentage of ethanol content in gasoline must be of a higher percentage, which is 70 – 85%.

### Question 3:

***Are there any other critical storage and handling equipment which must be compatible with E85, labelled and identify for E85 only?***

30. All equipment used in the E85 supply chain must be compatible with E85. However, with regard to storage and handling only, (and not retail as we will discuss Retail identification at length in Q4), E85 infrastructure is a further level of compatibility beyond Gasoline, so E85 infrastructure is compatible with E85 and Gasoline, but Gasoline infrastructure is only compatible with Gasoline, so if anything Gasoline infrastructure should be labeled as Gasoline “ONLY” not E85 as E85 Only, but regardless the product tanks will be marked and identified as E85 for the internal purpose of providing the end user with the correct product. This compatibility extends to the consumer also. A flex fuel vehicle is compatible with E85 and Gasoline, but a Gasoline vehicle is not compatible with E85. So unlike a diesel vs gas misfuelling error, an E85 vs Gas misfuelling error in 50% of cases is completely acceptable, and in the other 50% might also not cause any noticeable issue, or require any remedy on a single misfuelling; in comparison to the requirement of an immediate draining of tank being required if diesel is put in a gas tank or vice versa. See Q4 for further details. N.B., The Consultation’s (FS 2023-2-Ethanol Blended Gasoline-E85) and Paper’s statements regarding hygroscopic properties reflect a partial understanding of the minimal risks associated with Flex Fuels. Water separation actually occurs more readily in straight petroleum. To quote Mercury Marine, ethanol blended gasolines “may actually be a superior marine fuel as it tends to keep low levels of water moving through the fuel system, keeping the system dry”. Similar unwarranted concerns were raised in 2017 when the Office refused our first Import Permit application inhibiting the introduction of renewable content E10 gasoline into the Market for the first time. Five years later there has been “no reported negative impact”(C8 The Committee Paper) from E10 and we predict the same from the further availability of E85. Regardless, gauge systems contain information on tank water content, and turnover will be too rapid for material condensation.

### Office Response

31. The Office noted Refuel’s response.

### Question 4:

***Should there be a pump attendant at the nozzle alerting consumers to the E85? Should consumer be responsible for labelling their tank nozzle to alert pump attendants of their vehicle compatibility to E85?***



32. In response to customers labelling their fueling port tank nozzle. The vast majority, if not all flex fuel vehicles come with labelling as standard from the manufacturer. It is primarily marked with YELLOW gas caps and “Flex Fuel” wording. Please see Q5 with quotes and images from US Dept of Energy, Kelly Blue Book and Car & Driver Magazine evidencing this, as well as an example image of the type of labelling already used by manufacturers. As such this should not be of any concern as it has already been addressed. In response to the attendant. If one puts Diesel in a Gasoline engine or vice versa this is a significant issue and the fuel tanks have to be dropped and lines flushed. Whereas if one puts gasoline in a Flex fuel vehicle, the vehicle is designed for that, so nothing happens at all in these 50% of scenarios, and if one puts Flex fuel in a gasoline engine, on one single fueling it is highly likely that also nothing noticeable happens. It is incredibly disproportionate that the Consultation suggests mandating an attendant for Flex fuel pumps, but not every single diesel pump on Island or as a requirement of sale of this same product from the existing provider where no attendant is currently required to alert the customer at time of sale.
33. This suggested regulation is also incredibly costly, and since it doesn't solve any actual foreseen issue at all, as we will now show, also discriminatory. Refuel's pumps are incredibly well labeled, marked and color-coded to the effect that only 5 of roughly 300,000 transactions a year result in misfuelling errors (for further note, of those 5 about 80% of them are due to verbal miscommunication between an attendant and customer, not insufficient labelling, which would potentially make adding an attendant a more damaging scenario).
34. Our E85 is extremely well labelled. We do not anticipate any worse of an error rate than the extremely minimal rate that currently exists, and as discussed above 50% of any error rate causes no damage at all. Everything from the top decal, to the product decal, to the button one physically has to press, to the hose notification, to the nozzle colour is all marked YELLOW for E85 and labelled numerous times. Similar coding and labelling is present for Diesel and Gas and as shown has resulted in incredibly few errors.
35. Yet this suggestion to add an attendant will cost Refuel roughly KY\$60,000/year to “solve” what is actually a non-existent and incredibly low risk issue that would otherwise only cost Refuel roughly KY\$1-2,000/year in damages. The action thus discriminates against this renewable product for the Island and Refuel, in a way not seen between other products, or locations, raises fuel costs, and does not protect the consumer any material amount. If allocated directly onto this product this action would raise costs in excess of 20-50c per gallon.
36. Refuel is already aligned without further regulation with protecting the consumer and preventing mis-fueling which is evidenced historically with our fewer than 0.005% incorrect fueling rate. We do not foresee this being a material issue worth any more of anyone's time.

### **Office Response**



37. The Office believes an attendant at the E85 nozzle will educate the new consumer of E85 who does not have flex fuel vehicle, of the possible problems which could occur. It is to protect the unassuming customers from making decision to fuel their vehicle without knowledge of what are the consequences of their decision.
38. The Office disagrees with the comparison with diesel/gasoline misfuelling as this is a misunderstanding of the Office's concern, which is, the unassuming gasoline customer continuing to fuel their vehicle with E85 to their detriment because of their vehicle incompatibility with the fuel.

**Question 5:**

***What is the suggested colour to identify E85 fuel on the storage tank, pump nozzle, consumer's fuel tank?***

39. The Paper states in multiple sections that YELLOW is the recognized and familiar standard. We are of the same understanding and accordingly designed our labelling as such. Images 1 through 6 from the US Dept of Energy, Kelly Blue Book and Car and Driver Magazine show that YELLOW should be the identifying colour, and also provide examples of the types of labelling already in use by manufacturers We have also colour coded and branded all of our E85 locations as above from top to bottom in Yellow for this reason.
40. We have also colour coded and branded all of our E85 locations as above from top to bottom in Yellow for this reason

**Office Response**

41. The Office noted Refuel's response.



## E. Determinations

42. Having considered all the submissions made by the respondents, whilst the Office acknowledges the points of view, it maintains its proposed determination as its final position in **FS 2023 – 2 – Ethanol Blended Gasoline E85 Importation and Consumption Consultation**.
43. The Office is in favour of introducing E85 to the Cayman Islands fuel mix. It is considered a favourable alternative to conventional gasoline in FFVs only due to E85's ability to reduce greenhouse gas emissions. Introducing E85 to the Cayman Islands fuel mix increases diversification in the fuel mix. Diversification promotes competition in the market and can potentially lead to improved fuel pricing. Introducing E85 promotes innovation and investment in alternative fuel technologies which increases the advancement of renewable energy.
44. Section 10F (2) (h) of the DSA provides the office with the power to request information to carry out its duty. In order for the Office to carry out its duty to effectively monitor and enforce fuel quality standards, it is paramount that the Office requires all fuel importers to submit a certificate of analysis (COA). This promotes transparency, accountability and provides consumers with confidence in the quality of the fuel they are purchasing. Requiring all importers to submit COA's promotes a fair and level playing field and helps protect the interests of both the stakeholders and consumers.
45. Attendants at the E85 nozzle serve as a crucial point of contact for addressing concerns and educating consumers on the parameters, unique properties, and compatibility of E85 with their vehicle. The attendant acts as a "gatekeeper" to prevent misfuelling incidents and helps to build public trust and confidence in the use of E85.
46. The colour yellow is universally recognized for identifying E85 across various areas including storage tanks, pump nozzles and consumer's fuel tank. This standardized approach helps consumers and other persons to easily distinguish E85 from other options and promotes transparency and consumer confidence in the fueling process.



## **F. Appendix 1:**

### **Ethanol Blended Gasoline - E85**



## G. Appendix 2: Applicable Laws

Regulation 31 of the DSR:

*31. The standards applicable to dangerous substances imported into the Islands shall be the standards set by the Fuel Standards Committee in accordance with the Law and every person to whom an import permit is granted shall ensure that the dangerous substance imported by him accords with such standards.*

47. Section 9A (1) of the DS Act states:

*“There is established a Fuel Standards Committee to carry out the duties specified in this Law and the Committee shall consist of –*  
*(a) the Chief Fuels Inspector who shall be chairperson;*  
*(b) the Director of the Department of Environmental Health or his nominee;*  
*(c) the Director of Environment or his nominee;*  
*(d) the Director of the Water Authority or his nominee; and*  
*(e) Repealed by section 8 of Law 52 of 2016.*

48. Section 9A (3) of the DS Act states:

*(3)The Committee may appoint or empanel sub-committees, whether from among members of the Committee or from among persons outside of the Committee or both, to study and make recommendations to the Committee on any aspect of the regulation of fuel quality and related issues referred by the Committee.*

49. Section 9A (4) of the DS Act states:

*(4) Members of a sub-committee who are not members of the Committee are required to have-*  
*(a) relevant scientific or technical knowledge in the area of fuel quality standards;*  
*or*  
*(b) qualifications in chemistry, biology or environmental studies,*  
*or both such knowledge and qualifications; and such members shall be paid allowances as the Board may determine.*

50. Section 9B of the DS Act States:

*9B. The Committee shall carry out such duties as are specified in this Law and in regulations and such duties may include -*  
*(a) establishing the standards of certain types of fuel to be imported, distributed and used in the Islands;*  
*(b) publishing or causing to be published, in such medium as they determine, such standards and the testing methods to be used by importers and the Chief*



*Fuels Inspector in the inspection of fuel in order to ensure compliance with the standards; and*  
*(c) providing quarterly, bi-annual, annual or such other periodic reports to the Minister on its operations.*

Section 9(D) of the DS Act states

*9D. (1) Where, after inspections are carried out in accordance with this Law, it is found by the Chief Fuels Inspector or by an inspector that an importer has been importing and distributing to operators fuel which does not accord with standards published under section 9B, the Chief Fuels Inspector shall require the importer to comply forthwith with any written direction not inconsistent with this Law which the Chief Fuels Inspector believes on reasonable grounds is necessary to ensure that the importation or distribution of such fuel is immediately discontinued.*

*(2) An importer who fails to comply with a direction under subsection (1) commits an offence and is liable to an administrative penalty; and the relevant import permit of such person may be suspended, or revoked in accordance with the procedure set out in this Law.*

*(3) An importer who, more than once in any period of one year, imports and distributes fuel which is found by the Chief Fuels Inspector not to be in accordance with the standards set by the Fuel Committee commits an offence and is liable to an administrative penalty; and the relevant import permit of such person may be suspended, or cancelled in accordance with the procedure prescribed by this Law.*



(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 Volatil 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 number (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 – Volatility Class - 1	ASTI 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>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 (%)	3-19	1-8	Varies
Temperature (approx.) (*F)	850	495	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.