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Draft Zambian Standard

DENATURED FUEL ETHANOL FOR BLENDING WITH GASOLINES FOR USE AS AUTOMOTIVE SPARK – IGNITION ENGINE FUEL – Specification

ZAMBIA BUREAU OF STANDARD

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This Draft Zambian Standard was prepared by the…… Technical Committee, (TC…), upon which the following organizations were represented:

Biofuel Association of Zambia
Copperbelt Africa Investment
CFAO Motor Zambia Limited
Energy Regulation Board
INDENI Petroleum Refinery Company Limited
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TABLE OF CONTENTS

FOREWORD

The preparation of this Standard has been undertaken by the …… Technical Committee (TC…), in accordance with the procedures of ZABS. All users should ensure that they have the latest edition of this publication as standards are revised from time to time.

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The revision of this standard was necessary to ensure that the technological advancements in the sector are taken into consideration.

In the preparation of this standard, the following publication was consulted:

ASTM D4806:2006 - Denatured FuelEthanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel.

SANS 465:2005 - Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel.

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Draft Zambian Standard

DENATURED FUEL ETHANOL FOR BLENDING WITH GASOLINES FOR USE AS AUTOMOTIVE SPARK-IGNITION ENGINE FUEL – Specification

1.0 SCOPE

1.1 This specification covers nominally anhydrous denatured fuel ethanol intended to be blended with unleaded gasolines at 1 to 85 volume % for use as a spark-ignition automotive engine fuel. The specified properties are as given in Appendix A.

1.2 All values are stated in SI units, except for acidity and solvent-washed gum.
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2.0 NORMATIVE REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this standard are encouraged to take steps to ensure the use of the most recent editions of the standards indicated below. Information on currently valid National and International standards can be obtained from Zambia Bureau of Standards.

ZS ASTM D 381	Test Method for Gum Content in Fuels by Jet Evaporation (ISO 6246)
ZS ASTM D 512	Test Method for Chloride Ion in Water (D4929 B/EN 15484/EN 15492)
ZS ASTM D 1613	Test Method for Acidity in Volatile Solvents and Chemical Intermediates Used in Paint, Varnish, Lacquer, and Related Products (EN 15491
ZS ASTM D 1688	Test Method for Copper in Water (EN 15488)
ZS ASTM D 4057	Practice for Manual Sampling of Petroleum and Petroleum Products
ZS ASTM D 5453	Test Method for Determination of Total Sulphur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oil by Ultraviolet Fluorescence (EN 15485)
ZS ASTM D 5501	Test Method for Determination of Ethanol Content of Denatured Fuel Ethanol by Gas Chromatography
ZS ASTM D 6423	Test Method for Determination of pHe of Ethanol, Denatured Fuel Ethanol, and Fuel Ethanol (Ed75-Ed85) (EN 15490)
ZS ASTM E 203	Test Method for Water Using Volumetric Karl Fischer Titration (EN 15489/ISO 12937)
ZS ASTM E 300	Practice for Sampling Industrial Chemicals
EN 1601	Method of test for petroleum and its products. Liquid petroleum products. Unleaded petrol. Determination of organic oxygenate compounds.
ZS 396 - 1:	Manual Sampling of liquid hydrocarbons
ZS 868	Anhydrous Ethanol Fuel Blends Quality Standards for Automotive Spark Ignition Engines – specifications.

United States Code of Federal Regulations, Title 27, Parts 20 and 214
United States Federal Specification O-E-760b Ethyl Alcohol (Ethanol).

3.0 TERMINOLOGY

3.1. Definitions:

3.1.1 **Anhydrous**: compound that does not contain water.

3.1.2 **Ethanol:** n - ethyl alcohol, the chemical compound C2H5OH.

3.1.3 **Gasoline**: A volatile mixture of liquid hydrocarbons, generally containing applicable amounts of additives, suitable for use as a fuel in spark-ignition internal combustion engines.

3.1.4 **Gasoline-ethanol blend**: A fuel consisting of gasoline along with amounts of denatured fuel ethanol.

3.1.5 **Oxygenate:** An oxygen-containing, ashless, organic compound, such as an alcohol or ether, which may be used as a fuel or fuel supplement.

3.2. Definitions of terms specific to this standard:

3.2.1 **Denaturants:** Natural gasoline (unleaded), gasoline components, or toxic or noxious materials added to fuel ethanol to make it unsuitable for beverage use but suitable for automotive use.

3.2.2 **Denatured fuel ethanol:** Fuel ethanol made unfit for beverage use by the addition of denaturants.

3.2.3 **Fuel ethanol:** Ethanol with impurities common to its production (including water but excluding denaturants).

3.2.4 **Impurities:** In commercially produced fuel ethanol, compounds other than ethanol or denaturants present, such as methanol and fusel oil (for example, amyl and isoamyl alcohols).

3.2.5 **pHe:** A measure of the acid strength of alcohol fuels.

4.0 PERFORMANCE REQUIREMENTS

4.1. **Denatured Fuel Ethanol:** When fuel ethanol is denatured, it shall conform to the following requirements (Table 1) at the time of blending with a gasoline:

TABLE 1: PERFORMANCE REQUIREMENTS FOR DENATURED FUEL ETHANOL

CHARACTERISTIC	REQUIREMENT	TEST METHOD
Ethanol, volume %, min	92.1	ASTM 5501
Methanol, volume %, max	0.5	ASTM 5501/EN 1601
Solvent-washed gum, mg/100 mL, max	5.0	ASTM 381/ISO 6246
Water content, volume %, max	1.0 (Note 1)	ASTM E 203/ISO 12937 /EN 15489
Denaturant content, volume %	2.0 - 5.0	-

Inorganic chloride content, ppm, max	40	ASTM D 512/ASTM D 4929 B/EN 15484/EN15492
Copper content, ppm	0.1	ASTM D 1688 A/EN 15488
Acidity (as acetic acid CH_3COOH), mass % (mg/L), max	0.007 (56) (Note 2)	ASTM D 1613/EN 15491
pHe	6.5 - 9.0	ASTM D 6423/EN 15490
Sulphur, mass ppm, max	10	ASTM D 5453/EN 15485
Appearance	Visibly free of suspended or precipitated contaminants (clear and bright)	Visual

NOTE 1—In some cases, lower water content may be necessary to avoid phase separation of a gasoline-ethanol blend at very low temperatures. This reduced water content, measured at the time of delivery, shall be agreed upon between the supplier and purchaser.

NOTE 2—Denatured fuel ethanol may contain additives, such as corrosion inhibitors and detergents, that may affect the titratable acidity (acidity as acetic acid) of the finished fuel ethanol. Although the base fuel ethanol may meet the acidity specification, the effectof these additives may produce an apparent high titratable acidity of the finished product. Contact the ethanol supplier if there is a question regarding the titratable acidity of your denatured fuel ethanol to verify that the base ethanol meets the acidity requirements of 4.1.

4.2. Other Properties: Limits more restrictive than those specified above, or the specification of additional properties such as colour, may be agreed upon between the supplier and the purchaser.

5.0 WORKMANSHIP

5.1 The fuel ethanol shall be visually free of sediment and suspended matter. It shall be clear and bright at 21°C (70°F) or higher.

5.2 The specification defines only a basic purity for this product. The product shall be free of any adulterant or contaminant that may render the material unacceptable for its commonly used applications.

6.0 SAMPLING, CONTAINERS AND SAMPLE HANDLING

For the purpose of this Zambian Standard all sampling shall be carried out in accordance with the relevant procedures of ZS 396 Part 1: and ZS869.

All intended test methods should be reviewed prior to sampling to better understand the importance and effects of sampling technique, proper containers, and special handling required for each test method.

A minimum sample size of 1L is recommended.

APPENDIX A
(Informative)

SIGNIFICANCE OF SPECIFIED PROPERTIES

A.1 Denatured Fuel Alcohol

A.1.1 **Water Content -** Karl Fischer analysis is generally the only consistently reliable procedure for the determination of water in denatured ethanol. Test Method ZS ASTM E203 describes the modifications required to run the test in the presence of alcohols. Specific gravity methods such as Test Methods ZS ASTM D 891 and ZS ASTM D 3505 are generally unsuitable for the reasons given in **A.2.1**. Blends of fuel ethanol and gasoline have a limited solvency for water. This solvency will vary with the ethanol content, the temperature of the blend, and the aromatic content of the base gasoline. A fuel made by blending 10 volume % fuel ethanol with a gasoline containing 14 volume % aromatics and 0.6 mass % dissolved water (about 0.5 volume %), will separate into a lower alcohol-rich aqueous phase and an upper hydrocarbon phase if cooled to about 7°C (45°F). As normal spark-ignition engines will not run on the aqueous phase material, such a separation is likely to cause serious operating problems. Since some degree of water contamination is practically unavoidable in transport and handling, and because gasoline-ethanol blends are hygroscopic, the water content of the denatured fuel ethanol must be limited when it is blended with gasoline to reduce the risk of phase separation.

A.1.2 **Solvent-Washed Gum Content:**

A.1.2.1 The test for solvent-washed gum content measures the amount of residue after evaporation of the fuel and following a heptane wash. The heptane wash removes the heptane-soluble, nonvolatile material such as additives, carrier oils used with additives, and diesel fuels. Solvent-washed gum consists of fuel-insoluble gum and fuel-soluble gum. The fuel-insoluble portion can clog fuel filters. Both can be deposited on surfaces when the fuel evaporates.

A.1.2.2 Solvent-washed gum can contribute to deposits on the surfaces of carburettors, fuel injectors, and intake manifolds, ports, valves, and valve guides. The impact of solvent-washed gum from pure alcohols such as ethanol on malfunctions of modern engines is not known. The test method is used essentially to detect the presence of high boiling, heptane-insoluble impurities.

A.1.2.3 Since the precision statements for Test Method D 381 were developed using only data on hydrocarbons, they may not be applicable to denatured fuel ethanol.

A.1.3 **Total chlorine –** Ionic (inorganic) and organic chlorine are corrosive to many metals, and it is desirable to minimize organic and ionic chlorine compounds in fuel ethanol.

Actual chlorine limit of 2mg/kg, maximum, has been found to be inadequate in protecting some fuel system components. An inorganic chloride limit of 1mg/kg, maximum, is specified to provide additional protection.

A.1.4 **Copper Content -** Copper is a very active catalyst for the low-temperature oxidation of hydrocarbons. Experimental work has shown that copper concentrations higher than 0.012 mass ppm in commercial gasolines may significantly increase the rate of gum formation.

A.1.5 **Acidity -** Very dilute aqueous solutions of low-molecular weight organic acids such as acetic (CH_3COOH) are highly corrosive to many metals. It is therefore necessary to keep such acids at a very low level.

A.1.6 **pHe** - When the pHe of ethanol used as a fuel for automotive spark-ignition engines is below 6.5, fuel pumps can malfunction as a result of film forming between the brushes and commutator, fuel injectors can fail from corrosive wear, and excessive engine cylinder wear can occur. When the pHe is above 9.0, fuel pump plastic parts can fail. The adverse effects are less when ethanol is used at 10 volume % in a blend with gasoline.

A.1.7 **Appearance** - Turbidity or evidence of precipitation normally indicates major contamination.

A.1.8 **Ethanol Purity** - The presence of even small quantities of some organic oxygen compounds other than ethanol may adversely affect the properties of fuel ethanol-gasoline blends.

A.2 Undenatured Ethanol

A.2.1 **Specific Gravity -** The density of a water-ethanol mixture is primarily a function of its water content. Normal industry practice calls for the use of the 15.56/15.56°C (60/60°F) specific gravity in air as the control method for water content of undenatured ethanol. Since the addition of denaturants will normally affect specific gravity, specific gravity methods are generally not suitable for determining the water content of denatured ethanols.

A.2.2 **Sulphur Content -** Sulphur contaminates the catalytic converter necessary for reducing emissions of HC, CO, and NOx.

APPENDIX B
(Informative)

DENATURANTS

B.1 The only denaturant used for fuel ethanol shall be natural gasoline (unleaded), or gasoline components at a minimum of two parts by volume per 100 parts by volume of fuel ethanol,

B.2 Prohibited Denaturants - Although this specification permits only hydrocarbons in the gasoline boiling range to be used as denaturants, specific mention must be made of some materials that have extremely adverse effects on fuel stability, automotive engines, and fuel systems. These materials shall not be used as denaturants for fuel ethanol under any circumstances. They are as follows: methanol which does not meet Specification D 1152, pyrroles, turpentine, ketones, and tars (high-molecular weight pyrolysis products of fossil or nonfossil vegetable matter). While any significant amount of methanol will lower the water tolerance and increase the vapour pressure of a gasoline-ethanol blend, these effects become more serious when methanol is present at more than 2.5 parts by volume per 100 parts by volume of fuel ethanol. Also, methanol, which does not meet Specification D 1152, frequently contains impurities, such as turpentine and tars. Similarly, ketone denaturants tend to degrade fuel stability or increase the tendency of a gasoline-ethanol blend to corrode metals and attack elastomers. These effects become more serious if the concentration of a ketone such as 4-methyl pentanone (methyl isobutyl ketone) exceeds one part by volume per 100 parts by volume of fuel ethanol. There is no information available on the effects of denaturants other than those mentioned above; but unless a denaturant, such as higher aliphatic alcohol or ether, is known to have no adverse effect on a gasoline-ethanol blend or on automotive engines or fuel systems, it shall not be used.