AIS-XYZ

DRAFT

AUTOMOTIVE INDUSTRY STANDARD

SAFETY AND PROCEDURAL REQUIREMENTS FOR TYPE APPROVAL OF PURE ETHANOL, FLEX-FUEL & ETHANOL-GASOLINE BLEND VEHICLES

Date of Hosting: 22nd December 2020

Comments, if any, on the document should be forwarded on email- (**comments-morth@gov.in**) within period of thirty days.

INTRODUCTION

The Government of India felt the need for a permanent agency to expedite the publication of standards and development of test facilities in parallel when the work on the preparation of the standards is going on, as the development of improved safety critical parts can be undertaken only after the publication of the standard and commissioning of test facilities. To this end, the erstwhile Ministry of Surface Transport (MOST) has constituted a permanent Automotive Industry Standards Committee (AISC) vide order No. RT-11028/11/97-MVL dated September 15, 1997. The standards prepared by AISC will be approved by the permanent CMVR Technical Standing Committee (CMVR-TSC). After approval, the Automotive Research Association of India, (ARAI), Pune, being the Secretariat of the AIS Committee, will publish this standard. For better dissemination of this information ARAI may publish this document on their Web site.

Ethanol holds promise to provide clean, reliable and sustainable energy supply for meeting the growing demand of transportation fuels in the country. Also known as ethyl alcohol or grain alcohol, ethanol (C_2H_5OH) is an oxygenated hydrocarbon compound. In India, it is produced primarily from sugarcane. In order to accelerate the development and utilization of ethanol energy in the country, a National Biofuels Policy was announced in 2018by Ministry of Petroleum and Natural Gas. At present 10 % ethanol is blended with Gasoline and the Ministry of petroleum seeks to increase the blending percentage to 20 %. Further there is a plan to introduce E-85 and E-100 Vehicles in India in regions that are surplus in ethanol.

An AISC panel has been constituted vide the directions RT-11036/ 111/2020-MVL dated 16th September 2020 received from Ministry of Road Transport to formulate Automotive Industry Standard for type approval of ethanol blends, flex fuel and pure ethanol vehicles.

This standard specifies safety related performance and code of practice for ethanol fuelled vehicles in blended, flex fuel or pure form. The purpose of this standard is to enhance vehicle safety by specifying safety requirements for hazards such as fire, corrosion, exposure to fumes etc. The Composition of the Panel and Automotive Industry Standards Committee (AISC) responsible for preparation and approval of this standard are given in Annexure

1.0Scope

This standard is applicable to ethanol fuelled vehicles of category L, M & N incorporating ethanolblended petrol, or flexible fuel ethanol system or ethanol additive system or pure ethanolvehicles. This standard is only applicable to dedicated ethanol vehicles manufactured by Original Equipment Manufacturer (OEM) and warranted to use fuel with the respective high biofuel content. This standard is neither applicable for retro-fitted vehicles and machinery, nor for fuel cell vehicles.

2.0 References

Considerable assistance has been taken in formulating this document from international references as below

2.1 USDOE Handbook for Handling Ethanol Gasoline Blends, DOE/GO-102016-4854 dated Feb 2016

2.2 IEA – Advanced Motor Fuels- Report on Ethanol as a fuel for Road Transportation – May 2009

2.3 Renewable Fuels Association (RFA)- Industry Guidelines, Procedures and Specifications – E85 as an automotive fuel – March 2009

2.4 NREL - Vehicle Codes and Standards – Alternative Fuels, NREL/TP-560-47336- February 2010

2.5 ACS – American Chemical Society**https://pubs.acs.org/doi/10.1021/acsomega.8b03686**

3.0 Definitions

3.1Ethanol Fuel: Pure Ethanol, also called ethyl alcohol, pure alcohol, grain alcohol, or drinking alcohol, is a volatile, flammable, colorless liquid and has a strong characteristic odor.

3.2E-10: It is a blend of 10 % ethanol with 90 % Gasoline to be used in vehicles fitted with spark ignited engines.

3.3E-12: It is a blend of 12 % ethanol with 88 % Gasoline to be used in vehicles fitted with spark ignited engines.

3.4E-15: It is a blend of 15 % ethanol with 85 % Gasoline to be used in vehicles fitted with spark ignited engines.

3.5E-20: It is a blend of 20 % ethanol with 80 % Gasoline to be used in vehicles fitted with spark ignited engines.

3.6E-85: It is termed as flex fuel and is a flexible blend which varies as per speed and load on the vehicle from 53 to 85 % ethanol with 47 % to 15 % Gasoline and is used in vehicles fitted with spark ignited engines.

3.7ED-95: It is a blend of 95 % ethanol with 5 % Additive to be used in vehicles fitted with compression ignition engines.

3.8 E-100: It is 100 % pure ethanol fuel to be used in vehicles fitted with spark ignited engines.

4.0 Requirements

4.1Ethanol Fuel Quality Requirements for Safety

4.1.1Ethanol as a fuel for automotive use has been defined by BIS vide standard IS: 15464 (2004). The table 1 below lists the quality requirements for ethanol fuel as specified in the standard.

Table 1 Requirements of Anhydrous Ethanol for Use in Automotive Fuel

(*Clauses* 4.3, 4.5, 4.6 *and* 7.1)

Sl No.	Characteristic	Requirement	Method of Test, Ref to Annex
(1)	(2)	(3)	(4)
i)	Relative density at 15.6 /15.6 °C, *Max*	0.796 1	A
ii)	Ethanol content percent by volume at 15.6/15.6 °C, *Min* (excluding denaturant)	99.50	B
iii)	Miscibility with water	Miscible	C
iv)	Alkalinity	Nil	D
v)	Acidity (as CH_3COOH) mg/l, *Max*	30	D
vi)	Residue on evaporation percent by mass, *Max*	0.005	E
vii)	Aldehyde content (as CH_3CHO) mg/l, *Max*	60	F
viii)	Copper, mg/kg, *Max*	0.1	G
ix)	Conductivity, µS/m, *Max*	300	H
x)	Methyl alcohol, mg/litre, *Max*	300	J
xi)	Appearance	Clear and bright	Visual

4.1.2 Prior to being transported ethanol fuel must be denatured by adding approximately 2% hydrocarbons, such as natural gasoline, to render it unfit for human consumption. Other denaturants like petroleum ether or cyclohexane are acceptable but the use of ketones (e.g. methyl ethyl ketone) is not permitted as this has been known to affect fuel stability; furthermore, ketones have been known to be incompatible with metals and elastomers to some degree.

4.1.3 It is possible for water to contaminate ethanol during the production process or during storage and transportation. The maximum permissible water content for ethanol as a blending component is defined as 0.3 percent. This maximum limit becomes important when blended into petrol. Gasoline fuels containing ethanol only have limited water absorption capacity; this depends on the ethanol content, the content of aromatic compounds of the base fuel and the temperature. Having a water content above the solubility limit causes the ethanol fuels to separate, forming a water/ethanol phase and a separate hydrocarbon phase. Neither of both phases is acceptable. The separate hydrocarbon phase, e.g., is low in octane, the water/ethanol phase is particularly aggressive toward iron. The corrosiveness toward ferrous metals already increases if the water content approaches the separation limit.

4.1.4 A corrosion inhibitor is also added as an additive to the fuel. Detergents or deposit control additives may be needed to ensure deposits do not form in the vehicle fuel injection system.

4.1.5Ethanol Quality is driven by both the national Fuel Standards and octane requirements. The important chemical properties of ethanol affecting safety are given below in Table 2

4.1.6. Ethanol and petrol have different explosion limits. An explosive gas atmosphere in an E85 fuel tank will exist across a wider temperature range than in a petrol storage tank. For petrol the temperature range at which a gas atmosphere in a closed container is explosive ranges typically from - 41 ^{o}C to - 10 ^{o}C and for E85 from - 33 ^{o}C to + 11 ^{o}C for E85. Extra precautionary measures for handling high ethanol blends may be necessary. It is rare but it has occurred that static electricity has caused small fires or small flames that have quickly gone out during the filling up of vehicles. Some form of flame arrester or a well-functioning interlocking shut-off valve may be necessary.

4.1.7. Ethanol contamination by sulfates and chlorides occur during ethanol production, or during storage and transportation. Even minimal sulfate impurities can facilitate the formation of deposits on gasoline injection components. These contaminants shall be limited at 1 mg/kg maximum to avoid engine issues.

Table 2: Ethanol Properties affecting Vehicle Safety (Source: USDOE)

Property	Comment
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 hydroscopic (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.

4.1.8 **Galvanic Corrosion Inhibitors for ethanol-gasoline blends**

Mixtures of ethanol and gasoline are designated as ethanol–gasoline blends (EGBs). Ethanol has high polarity and moisture affinity, which considerably influence their aggressiveness to many metallic and nonmetallic materials. The galvanic corrosion aggressiveness of EGBs can be minimized by suitable corrosion inhibitors. The inhibitors recommended for ethanol gasoline blends by the American Chemical Society (ACS) are 1) diethylene triamine (DETA) and mixed

inhibitors 2) propargyl alcohol, dibenzyl sulfoxide and 3) propargyl alcohol, octadecyl amine and mercaptobenzothiazole. The highest inhibitory efficiency is observed for the DETA inhibitor around 98%. The proportions of the inhibitors are given below in the Table 3.

Table 3: Galvanic Corrosion Inhibitors for Ethanol (Source : ACS)

Number	Inhibitors	Manufacturer Purity	Amount mg/L
1	Diethylene Triamine (DETA)	99 %	100
2	Propargyl Alcohol + Dibenzyl Sulfoxide	99 %	100+65
3	Propargyl Alcohol + Octadecyl Amine + Mercaptobenzothiazole	99 %	100+70+25

4.2Material Compatibility Recommendations for Use of Ethanol in Vehicles

4.2.1 As with all motor fuels, it is important to maintain proper fuel handling and housekeeping practices to minimize contamination. Certain materials commonly used with gasoline may be incompatible with mid- and high-level ethanol blends.Some materials may degrade over time, potentially leading to equipment problems. They may also contaminate the fuel, which may adversely affect vehicle fuel system operation or cause component malfunction and lead to degraded driveability and performance.

4.2.2 Ethanol blends impact metallic materials in fueling systems. Blends below E25 do not cause corrosion of metals, however blends above E25 can cause corrosion of some soft metals. Zinc, brass, lead, and aluminum have shown sensitivity to degradation with higher ethanol blends like E85 and E100. To address these issues, manufacturers have to upgrade materials and developengine and fuel system components that are compatible with ethanol.

4.2.3 Many elastomer materials (primarily used as hoses and seals) lose their tensile strength when exposed to ethanol. Nonmetallic materials that degrade when in contact with fuel ethanol include natural rubber, polyurethane, cork gasket material, leather, polyvinyl chloride, nylon 6/6, methyl-methacrylate plastics, and certain thermoplastic and thermoset polymers. Blends even below E25 may impact elastomers, and contact with E85 causes some elastomers

to swell.Nonmetallic materials successfully used for ethanol include thermoset-reinforced fiberglass, thermoplastic piping, and thermoset-reinforced fiberglass.

4.2.4 E85 acts like a cleaning agent and will initially mobilize sludge in storage tanks. 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.

4.2.5 Modified electrical wiring and connectors are required for submersed components, such as the fuel-level sensor and fuel pump.

4.2.6 Increased evaporative emissions carbon canister capacity, a modified fuel tank vapor pressure sensor, and modified engine valve and valve seat materials may also be required.

4.2.7 The list of fuel-system and engine components that must be modified include hoses and other rubber components, such as fuel pump and fuel pressure regulator diaphragms and fuel injectorO-rings, to address possible leakage and permeation of fuel vapor.

4.3Health Safety Considerations for Use of Ethanol in Vehicles

4.3.1Fuel ethanol should be handled in the same manner as gasoline. Personal exposure should be minimized.

4.3.2 Like gasoline, fuel ethanol is flammable and may contain additives that can be harmful even with casual contact.

4.3.3 Fuel ethanol is toxic and carcinogenic and should not be ingested. In case of accidental ingestion medical personnel must be contacted immediately.

4.3.4 Exposure to fuel ethanol can occur by inhalation (breathing in its vapors), absorption (contact with the skin or the eyes), or ingestion (swallowing). The various symptoms of exposure to fuel ethanol are shown in Table 4.

4.3.5 The station operators for filling the ethanol fuel or service mechanics for vehicle servicing or vehicle operators must use PPE equipment such as gloves, safety glasses and safety shoes when coming in contact with the ethanol fuel system.

4.3.6. The remedial measures when exposed to ethanol are listed in table 4.

Table 4: Safety precautions for Ethanol Exposure (Source: USDOE)

Symptoms of Exposure	• Dullness of memory and concentration • Impaired motor coordination • Drowsiness, stupor, and coma.
Exposure	**First Aid Treatment**
Inhalation	Move away from the vapors to fresh air, and contact medical personnel immediately.
Skin Absorption	Immediately wash skin with soap, and flush skin with plenty of water for at least 15 minutes. Remove contaminated clothing, and contact medical personnel.
Eye Absorption	Immediately flush eyes with plenty of water for at least 15 minutes, and contact medical personnel.
Ingestion	Lie down, keep warm, do not induce vomiting, and contact medical personnel immediately.

4.4Fire Safety Considerations for Use of Ethanol in Vehicles

4.4.1 Ethanol and ethanol-fuel blends are flammable liquids. The US DOT designates typical fuel ethanol per as a Class 3 Flammable Liquid.

4.4.2 Fighting fuel ethanol fires requires specific equipment, materials, and training. Conventional gasoline fire-fighting methods and chemicals are insufficient for fighting fires fueled by ethanol blends higher than E10.

4.4.3 Ethanol blended fuels with greater than 10% ethanol require the use of a Polar Solvent or Alcohol Resistant (AR) type of Foam commonly known as an AR-AFFF. AR foams have shown show superior performance across the entire range of ethanol blended fuels and would be the

best use of fire response equipment. The ethanol vehicles should be equipped with AR Foam based fire fighting canisters.

4.4.4 Depending on the hydrocarbon blending component, the vapor concentration in the storage tank of Ethanol blends can fall into the flammable range. This is a concern primarily at low ambient temperatures. Provisions for venting the ethanol vapors must be provided for dispersing the accumulated vapors.

4.4.5 Provision of UL certified flame arrestors and leak detectorsin the vehicle fuel system must be provided for addition safety

4.4.6Fire Extinguishers for Ethanol vehicles

FDSS system as specified in AIS 135 is recommended for ethanol vehicles. It has two functions as described below:

1. Fire detection and alarm system

2. Fire Suppression system.

AIS135 gives FDSS kit level test requirements and also installation requirements when fitted on vehicle. The ethanol vehicles should be equipped with AR Foam based fire-fighting canisters The recommended quantity of fire extinguisher is given below as per table 5.

Table 5 : Fire Extinguishers for Ethanol Vehicles

Category of Vehicle	**ED-95**	**E-20**	**E-85**	**E-100**
2 Wheelers	----	1/2 kg	----	1/2 kg
3 Wheelers	----	1 kg	-----	1 kg
PC/SUV	----	1 + 1 kg	1+1 kg	1+1 kg
Bus	2 + 2 kg	---	----	----

4.4.7 Ventilation for Ethanol Vehicles

The driver's area for air conditioned ethanol buses, passenger cars and SUVs. shall be provided with the blowers or other suitable devices to ensure proper ventilation. These devices shall be capable of minimum of three air changes per minute.

4.5Electrical Conductivity Considerations for Use of Ethanol in Vehicles

4.5.1 Ethanol and ethanol blends have increased electrical conductivity compared to gasoline. This can lead to increased galvanic corrosion of certain metal junctions and exposed electrical connections.

4.5.2 The addition of corrosion inhibitors in the fuel are recommended to reduce galvanic corrosion tendency of ethanol.

4.5.3 Provision for grounding of static charge buildup in the vehicle should be provided

4.5.4 Non Sparking tools should be used in the ethanol fuelled vehicle

4.6 Labeling of Ethanol Vehicles

4.6.1 Vehicles using E10, E12 and E15 may not require separate labeling

4.6.2 Vehicles using E20, E85, ED-95 and E-100 must use the labels in yellow background with Black letters. The width of label should be 20 mm, Height 40 mm, Font Height 9 mm with font thickness 2 mm

4.6.3 Figure 1 below shows the representative labels for different ethanol blend vehicles.

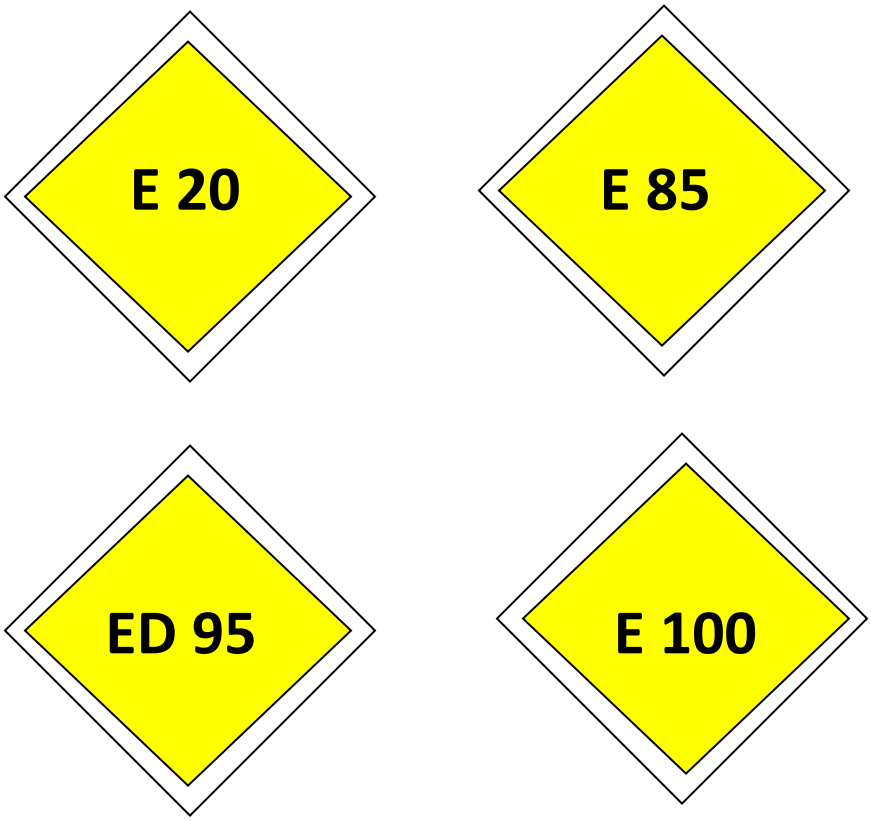

Figure 1 : Labeling for Ethanol Vehicles

ANNEXURE-VII

(See Introduction)

COMMITTEE COMPOSITION*

Automotive Industry Standards Committee

Chairperson	**Organization**
Dr. Reji Mathai	Director The Automotive Research Association of India, Pune
Members	**Representing**
Representative from	Ministry of Road Transport and Highways (Dept. of Road Transport and Highways), New Delhi
Representative from	Ministry of Heavy Industries and Public Enterprises (Department of Heavy Industry), New Delhi
Shri S.M.Ahuja	Office of the Development Commissioner, MSME, Ministry of Micro, Small and Medium Enterprises, New Delhi
Shri Shrikant R Marathe	Former Chairman, AISC
Shri R.R.Singh	Bureau of Indian Standards, New Delhi
Director	Central Institute of Road Transport, Pune
Director	Global Automotive Research Centre
Director	International Centre for Automotive Technology, Manesar
Director	Indian Institute of Petroleum, Dehradun
Director	Vehicle Research and Development Establishment, Ahmednagar
Director	Indian Rubber Manufacturers Research Association
Representative from	Society of Indian Automobile Manufacturers
Shri R.P. Vasudevan	Tractor Manufacturers Association, New Delhi
Shri Uday Harite	Automotive Components Manufacturers Association of India, New Delhi

Member Secretary
Shri Vikram Tandon
Dy. General Manager
The Automotive Research Association of India, Pune

* At the time of approval of this Automotive Industry Standard