

Technical and Facilities Services Branch

FACILITIES MAINTENANCE INSTRUCTION No. 6 / 2006

ETHANOL BLENDED UNLEADED PETROL (E10) STORAGE TANK CONVERSION

Outline

Reason for Issue:

- DEGRAM 75/2006 promulgated a direction to use E10 in Defence and Defence–leased vehicles. This technical instruction provides guidance for the conversion of unleaded petrol (ULP) storage tanks to be used for the storage of E10.

Summary of Maintenance Recommendations

- Carry out a condition assessment on the tank(s) and distribution infrastructure (pumps and piping), and complete a cost analysis to determine whether the facility/site is suitable for conversion.
- With the presence of ethanol and its affinity to water, it is essential to ensure the storage tanks and the site is water tight. Prior to accepting the first delivery petrol/Ethanol blend, the tank must be cleaned of water, rust and other foreign particles. The fitment of a filter between the tank and the dispensed point is required.
- Any consideration to the refurbishment of Ethanol/Petrol blend storage tanks or new facilities must comply with the appropriate Australian Standards, Fuel industry and Defence guidelines, and State and Territory legislation.

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Authorised for Release by Director Engineering Services and Technical Regulation, Aug 06.

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INTRODUCTION

1. In a press release dated 22 September 2005 the Commonwealth Government reaffirmed its commitment to achieving a National biofuel production target of at least 350 mega litres (ML) by 2010. This commitment was undertaken in response to recommendations made in the Final Report of the Commonwealth Government Biofuels Taskforce released in August 2005.
2. In order to achieve this goal and to improve the general populations confidence in ethanol blended fuels, the Commonwealth Government is encouraging users of unleaded petrol (ULP) powered Commonwealth vehicles to use unleaded petroleum fuel with up to ten percent ethanol (E10) where possible.
3. As Defence vehicles form part of the Commonwealth fleet, it is a requirement that vehicle users commence using E10 fuels, where possible.

Aim and Requirement

4. To ensure compliance with the above detailed directive, the purpose of this instruction is to provide guidance for the conversion of on-base fuel dispensing facilities that involve tank(s) (aboveground or underground) and distribution systems from unleaded petrol (ULP) to E10. In determining whether the facility/site is suitable for conversion it is essential, to carry out a condition assessment on the tank(s) and distribution infrastructure (pumps and piping), and complete a cost analysis. Should the Region determine the tanks and distribution infrastructure require refurbishment or replacement; such work must comply with the appropriate Australian Standards, Fuel industry and Defence guidelines, and State and Territory legislation.

BACKGROUND

5. Ethanol (ethyl alcohol - EtOH) in its pure form is a clear, colourless liquid alcohol which can be used as an alternative fuel. It can be produced from petroleum by industrial methods or derived from corn, wheat, potato wastes, cheese whey, rice straw, sawdust, urban wastes, paper mill wastes, molasses, sugar cane, seaweed, surplus food crops, and other cellulose waste.
6. EtOH is a useful solvent for many substances and is used in the manufacture of many products including perfumes, paints, lacquer, explosives and Biofuel. It is miscible (mixable) in all proportions with water and with most organic solvents and is a flammable liquid with a flash point of 13° C and burns with a colourless flame. EtOH has a flashpoint higher than that of Unleaded Petrol (ULP), and EtOH/petrol blends are flammable liquids requiring precautions similar to those for handling and storage of conventional petrol to be observed. Refer to paragraph 28 for Fire Safety control.

7. EtOH is most commonly used to increase octane ratings of, and improve the emission quality of petrol. It is recognised the emissions from EtOH blended fuels vary markedly between different EtOH/petrol blends and vehicle technologies, however within the Australian context, the use of ethanol blends of 10% ethanol/90% ULP (commonly known as E10) has been found to be greenhouse gas neutral. It should also be noted that E10 is the most common EtOH/petrol blend available worldwide; that the fuel is readily compatible with most modern automobiles and; with very little modification, E10 can be stored in existing distribution infrastructure.

8. At this stage the maximum content of EtOH allowed in Australian commercial ULP is 10% by volume (E10). However there are certain characteristics of EtOH that are different to those of straight ULP, and thus the fuel requires particular management techniques in order for it to be fit-for-purpose and meet the regulated fuel standards.

PETROL/ETHANOL BLEND CHARACTERISTICS

Affinity to Water

9. Petrol has negligible solubility in water while EtOH in contrast, is highly water soluble. Petroleum fuels distributions systems are generally not designed to be completely water tight but rather to tolerate small amounts of water. The ingress of water into a EtOH/petrol storage tank, results in the separation of water – alcohol phase from the petrol (phase-separation). The amount of water ‘tolerated’ by an EtOH/petrol blend varies both with the EtOH content and temperature. Meaning the lower the blend content, the lower is the tolerance for water; and the lower the temperature, the lower is the tolerance for water.

10. When phase-separation occurs in fuel tanks the result will be a reduced octane component in the petrol phase, and a separate water/EtOH phase with some hydrocarbons. As noted, the petrol phase will have a lower octane content which may impact vehicle driveability depending on the petrol quality used to make the blend. Additionally, the presence of a water/EtOH phase in the tank may foster microbial growth in tanks, and will encourage rust development. On the positive side EtOH will seek out any traces of water in a storage system and hold the water in solution.

Testing for water

11. 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/eEtOH 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.

12. It is also recommended that the residual fuel in the tank be tested for quality, to establish if separation of all or part of the EtOH has resulted in an off-specification mixture – if so, this should also be pumped out and replaced with a fresh EtOH/petrol blend.

13. Of note, discharge of water/EtOH phase mix into sewers, drains or waterways is not allowed. Therefore disposal of any water/EtOH phase or off-specification mixture must be done in accordance with local regulatory guidelines, possibility necessitating the disposal of the contaminated fuel at a licensed chemical disposal facility.

Vapour Pressure

14. Although EtOH has a lower vapour pressure than petrol, a blend of EtOH and petrol tends to disproportionately increase the vapour pressure which is dependent on the blend mix. For example E10 has a vapour pressure of approximately 130kPa, while ULP is typically about 70 kPa. Therefore it is strongly recommended to review vent design and configurations to prevent unnecessary emissions to atmosphere.

Solvent Properties

15. As mentioned earlier, EtOH has very good solvent properties, and its presence in EtOH/petrol blends tend to loosen rust, scale gum and other deposits in tanks and fuel systems. It is therefore important to ensure the removal of rust and other particles, particularly in steel tanks and associated piping, and the condition of the infrastructure prior to using them for EtOH/petrol fuels. Refer to Table Two in Appendix B for details related to the required infrastructure preparations to store EtOH/petrol blend fuels.

ENVIRONMENTAL CONSIDERATIONS

16. Due to its solubility in water and its chemical properties, EtOH will biodegrade quickly in water and soil. In water, the half life of EtOH is only a few hours. The very fact that EtOH biodegrades is a bonus, however because of the petrol component left behind, all fuel storage systems (tanks and pipe-work) should be monitored to detect any leaks quickly. Any consideration to the refurbishment of EtOH/petrol blend storage tanks or new facilities must include a condition assessment and such refurbishment work must comply with AS 1692 and AS 1940.

FUEL QUALITY

17. As this instruction is designed to provide guidance for the conversion fuel storage tanks from ULP to the E10 blend fuel, it important to recognise that fuel quality can go out of specification due to the presence of water. All care must be taken to ensure there is no water present in the storage tank and piping. It is equally important to ensure that upon receiving E10 it is within fuel specification. Out of specification E10, for whatever reason, should not be accepted. Note this instruction does not cover the condition and serviceability of tankers used by the supplier for delivery purposes to the dispensing point. Equally, Defence owned or leased tankers used for the sole purpose of transporting of already received E10 from the supplier, must be of an approved design suitable for E10.

MAINTENANCE

18. The maintenance of the EtOH/petrol blend fuel tanks should comply with the provisions of AS1692, AS 1940 and State and Territory legislative requirements and Industry and Department of Defence guidelines for the use, storage of E10 and the maintenance of the storage facilities.

19. Whilst general maintenance requirements for EtOH/petrol blend fuel is no different too what is required for petrol, additional consideration should be given to the following;-

- a. Ingress of water into the tanks;
- b. Cross contamination from water, lead fuels or diesel;
- c. Compatibility of materials; and
- d. Rust and scale contamination of pumps and filters.

20. Included in Table Two, are details of a checklist to be used when converting a fuel petrol tank and pipe work from petrol to EtOH/petrol blends. As with anything, preparation is the key to a successful outcome. The flow of the table is designed to highlight the first three important stages, 'Site Investigation and Preparation', 'Conversion Plan' and 'First Day Delivery' to achieve a successful outcome. The fourth stage, 'Ongoing procedures and maintenance requirements' highlights important aspects for the ongoing maintenance that must be included in the Regional Comprehensive Maintenance Services Contract under Performance Based Maintenance of FP&E.

21. As noted above in paragraph 15, EtOH has a good solvent effect (or cleaning effect). It is also recommended that 10 micron type filters be installed between the fuel storage tank and the final dispensing point to strain out any rust, scale, or dirt loosened from the tank walls or piping by the EtOH. These filters should be cleaned regularly. A good indication of blocked filter is the slowing of product delivery flow at the nozzle. It is also recommended that water absorbing filters be installed to reduce the possibility of dispensing a water/EtOH blend if this type of phase blend is present.

MATERIAL COMPATIBILITY

22. Care is required when assessing an existing facility being considered for the storage and dispensing of EtOH/petrol blend fuel E10. Like petrol, EtOH is a flammable liquid and therefore the tank design and maintenance requirements shall comply with the provisions of all applicable State and Territory legislative requirements, Industry guidelines and standards including AS 1692 and AS 1940.

23. Please refer to Table One in Appendix A for a list of materials compatible with E10. In general, as EtOH does not permeate or react chemically with steel, the use of steel tanks and pipe-work is considered suitable for the storage and distribution of EtOH/petrol blends. However there is a slight increased risk of corrosion associated with the presence of water should water separation phase occur or if water is allowed to accumulate at the bottom of the tank; and as EtOH/petrol blends are more conductive than petrol, there is a possibility of a slight increase of potential galvanic and electrolytic corrosion.

Tank linings

24. In the case of fibreglass reinforced plastic tanks and pipe-work or tanks with coatings/linings and pipe-work, confirmation should be obtained from the manufacturer of the tanks and pipe-work as to the compatibility with EtOH/petrol blends.

Pumps and Dispensers

25. As for terminal pumps where E10 is used, pump seals should be either carbon or ceramic. If unsure, check with the pump supplier. The Australian Institute of Petroleum have been advised by the pump manufacturer Gilbarco Australia Limited that the pumps and dispensers it currently supplies to the Australian market have been designed to cope with EtOH/petrol blend of no higher than 10 percent – E10. In addition, Gilbarco have provided the following warnings:-

- a. higher levels of EtOH may damage elastomers in seals, diaphragms and other components;
- b. aluminium, brass and zinc-plated components may be affected;
- c. nozzles constructed of Elaflex ZVA may be damaged by EtOH content exceeding 10%;
- d. Gilbarco also advised older Legacy pumps may not be able to handle EtOH/petrol blends at 10%.

If as the operator or maintainer you are unsure of the suitability of the equipment, it is recommended to check with the supplier of pumps and dispensers for information on compatibility with EtOH prior to the first delivery of EtOH/petrol blends, and the potential effect on warranties.

Sealants

26. For Pipe sealants where EtOH/petrol blends are in use, avoid alcohol base sealants. Suitable sealants are; scotch brand pipe sealant with Teflon No 4178; Loctite pipe sealant Teflon No 592; and permatex seals pipes No 804, or similar industry approved products.

Points to consider when converting infrastructure

27. Generally, the standard on-base ULP dispensing facility should be able to dispense E10. However there are three key points to consider before E10 is accepted:

- a. Carry out a condition assessment of the entire system (tanks, piping and pumps);
- b. Ensure the equipment is compatible with EtOH; and
- c. It is absolutely essential to ensure equipment and operating procedures are in place to keep the product free of water.

The necessary checks and steps are shown in Table Two in Appendix B.

FIRE PROTECTION AND OH&S

28. Personnel responsible for the management, maintenance and operation of fuel dispensing facilities, whether they be Military or Civilian personnel or contractor, must adhere to the Defence overarching guidelines for OH&S and Fire Safety, which include:-

- a. the Commonwealth Occupational Health and Safety legislation which includes Occupational Health and Safety (Commonwealth Employment) Act 1991 (OHS)

(CE) Act) and Occupational Health and Safety (Commonwealth Employment (National Standards) Regulations 1994 (OHS (CE) (NS) Regulations);

- b. the State/Territory OH&S legislation which includes, but is not limited to Dangerous Goods Regulations;
- c. Defence safety policy, guidance and advice provided by Defence Safety Management Agency (DSMA), legislation and Defence Safety Manuals (SAFETYMAN);
- d. DEF(AUST) 5695; Minimum Standards of Practice for the Storage, Handling and Quality Control of Fuels, Lubricants and Allied Products
- e. Guidance obtained from the DSMA publication - Contract Safety Management - A Framework for Safety in the Defence Contract Process; and
- f. MPFE and relevant Standards and Codes for fire safety.

Material Safety Data Sheets

29. In its pure form EtOH is toxic to humans. However, in small doses EtOH generally will place the person in a relaxed and euphoric mood; people experiencing these symptoms tend to become talkative and less inhibited, and may exhibit poor judgment. At higher dosages, EtOH acts as a central nervous system depressant, producing at progressively higher dosages, impaired sensory and motor function, slowed cognition, stupefaction and unconsciousness.

30. Material Safety Data Sheets (MSDS) should be provided for all personnel who work with EtOH, as with other petroleum fuels. MSDS's should be provided by EtOH suppliers. Similarly, personnel who work with EtOH/petrol blends should be provided with MSDS's for the fuel.

Fires Involving Petrol/Ethanol Blends

31. EtOH burns with a colourless flame, and may generate little or no smoke, making it difficult to determine the existence or the boundaries of its fire. Extra care should be taken in approaching such fires. In contrast, EtOH/petrol blends burn with the flame colour of the base petroleum fuel. The addition of EtOH to petrol leads to a moderate increase in the upper flammability limits. This is particularly increased if methyl tertiary butyl ether (MTBE), a chemical that may be present in ULP used as an oxygenate, is commingled. In general, fire fighting procedures for petrol should be followed. The following fire fighting agents are effective:

- a. Dry chemical, at the same application rate as for petrol, unless otherwise specified by the manufacturer; and
- b. Carbon dioxide at the rate of application as for petrol fires, unless otherwise specified by the manufacturer.

32. Spill fires (less than 5 mm depth) can be extinguished with aqueous film forming foams, polar solvent foams, fluoroprotein foams, and regular protein foams. In-depth fires can be extinguished with aqueous film forming foams, polar-solvent foams, and fluoroprotein foams. Sub-surface foam injection is not recommended.

Contact Details

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References

- Australian Institute of petroleum - *The storage, transport and handling of fuel ethanol and ethanol Blend fuels GL14- 2003*. <http://www.aip.com.au>
- Wikipedia encyclopaedia for Ethanol and E10. <http://en.wikipedia.org>
- Joint Fuels and Lubricants Agency.
<http://intranet.defence.gov.au/dmoweb/Sites/JFLA>
- DI(G) Log (draft) Interim Policy for the Introduction of E10 Fuels into Defence.
- Renewable Fuels association - *Fuel Ethanol Industry guidelines specifications and procedures October 2005* <http://www.ethanolrfa.org>.
- **American Petroleum Institute API 1626**. Storing and Handling of Ethanol and Gasoline-Ethanol Blends at Distribution Terminals and Service stations: 1985.
- **American Petroleum Institute API 4261**. Alcohols and Ethers: A Technical Assessment of their Application as Fuels and Fuel Components: 2001.
- **Australian Institute of Petroleum AIP CP4**. The Design, Installation and Operation of Underground Petroleum Storage Systems.
- **Australian Institute of Petroleum AIP CP8** Precautions against Electrostatic Ignition During Tank Vehicle Loading.
- **Australian Institute of Petroleum AIP CP14** Transport of Petroleum Products by Road.
- **Standards Australia AS 1692** Tanks for Flammable and Combustible Liquids
- **Standards Australia AS 1940** The Storage and Handling of Flammable and Combustible Liquids.

- **Underwriters Laboratory UL 1316** Glass-Fiber-Reinforced Plastic Underground Storage Tanks for Petroleum Products, Alcohols, and Alcohol-Gasoline Mixtures: 1987 and following.

Compatibility of Commonly Used Material with Ethanol and Ethanol Blends

<u>Recommended</u>	<u>Not Recommended</u>
<u>Metals</u>	
Aluminium (not for E85)	Zinc – galvanised (ethanol only)
Carbon steel	
Stainless steel	
Bronze	
<u>Elastomers</u>	
Buna-N (hoses & gaskets) ¹	Buna-N (seals only) ¹
Fluorel ¹	Neoprene (seals only)
Flurorosilicone ²	Urethane rubber
Neoprene (hoses & gaskets)	
Polysulfide rubber	
Natural rubber (ethanol only)	
Viteon ¹	
<u>Polymers</u>	
Acetal	Polyurethane ²
Nylon	Alcohol- based pipe sealant ²
Polypropylene	
Teflon ¹	
Fibreglass reinforced plastic ²	
Notes	
1. Registered trademark	
2. Manufacture of the product should be consulted.	

Table two

Fuel Dispensing/Outlet Checklist to Receive Petrol/Ethanol Blends

Step one - Site Investigation and Preparation	
Check point	Action
Tanks compliance	<ul style="list-style-type: none"> • Review regulatory compliance and suitability for E10
Tanks, (tank linings) and pipe-work	<ul style="list-style-type: none"> • Verify tank material compatibility with the petrol/ethanol blend. • Check history of tanks for signs of water ingress and repair. Investigate tank water problems and correct.
Fill point and dip point	<ul style="list-style-type: none"> • Ensure tight seals on fill caps and ensure proper water run off from manhole covers. Correct where necessary. • Ensure that product and water does not drain from the fill box via the foot valve into a tank holding E10.
Fill point marker	<ul style="list-style-type: none"> • Change fill point marker to clearly identify petrol/ethanol blend fuel.
Vent tubes	<ul style="list-style-type: none"> • Check vent for ingress of water and are clear of rubbish and debris.
Tank preparation	<ul style="list-style-type: none"> • Remove water from tank, clean and dry out tank. (The tank must be cleaned of loose materials, rust, varnish and gum). I also suggest check lead from lead fuels impregnated into the steel lining be carried out.
Step two - Conversion Plan	
Pumps, Hoses, nozzle and meters	<ul style="list-style-type: none"> • Check with pump manufacture that the dispenser/hose and nozzle can handle petrol/ethanol blend. • Equip pump or dispenser pumps with 10 micro filter to remove any suspended particulates and precipitates.
Tanks dewatering	<ul style="list-style-type: none"> • Recheck for water in the tanks and remove.
Tanks dips	<ul style="list-style-type: none"> • Issue Ethanol compatible pastes and discard old incompatible pastes.
Meters	<ul style="list-style-type: none"> • Note recalibrate after 10 to 14 days of operation to ensure that the change of product has not caused any meters to over dispense (only applicable if selling the product or recording volumes issued).

Fuel Dispensing/Outlet Checklist to Receive Petrol/Ethanol Blends	
Step three - First Delivery	
Tanks dewatering	<ul style="list-style-type: none"> • Check for water in tanks. The water must be removed before first delivery. • Test for water in the tanks (water bottoms) at least three times a day (24Hrs) or at the end of each shift for the first 48 hours after initial delivery. • Then check for water bottoms daily.
Pump labels	<ul style="list-style-type: none"> • Ensure correct proper pump labels are fitted.
Delivery	<ul style="list-style-type: none"> • Follow standard delivery procedures. • Hoses and piping must be purged to avoid the risk of cross contamination. • Verify with tanker driver correct compartment for correct tank. • Fill tanks to 80 % of capacity. Keep as full as possible for 7 to 10 days.
Pumps	<ul style="list-style-type: none"> • Pumps should be shut down during first delivery. • Replace pump/dispenser filters if running slow
Step four – On-going procedures and maintenance requirements	
Delivery	<ul style="list-style-type: none"> • To avoid the possibility of water contamination and where possible, deliveries should not be made during periods of rain. • The operator should check the hardstand area of the dispensing facility to ensure there is no freestanding water around the dip and filling points.
Maintenance	<ul style="list-style-type: none"> • Follow standard maintenance requirements including daily for water bottom checks. If water is found, have it removed at once. • Inspect pumps daily for signs of leaks caused by material incompatibility with ethanol. If a leak is found shut down the pump and repair immediately. Check pump calibration two weeks after initial delivery of petrol/ethanol blend. • Filters/strainers on pumps and pipes should be checked regularly – for example every two months - for rust or scale cleaned from the system by the Ethanol. Note once the tanks and pipes have been properly prepared for Ethanol use, further rust or scale is less likely to occur. • Leaks and spills of petrol/ethanol blends should be handled in the same way as petrol leaks and spills.

