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Fuel and oil safety

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Advisory circulars are intended to provide advice and guidance to illustrate a means, but not necessarily the only means, of complying with the Regulations, or to explain certain regulatory requirements by providing informative, interpretative and explanatory material.

Advisory circulars should always be read in conjunction with the relevant regulations.

Audience

This advisory circular (AC) applies to:

- Aircraft owners, operators, pilots and aerodrome operators where fuelling may take place.

Purpose

This AC provides guidance on procedures and practices to ensure the safety of fuelling operations.

Division 91.D.6 of CASR mandates certain responsibilities for safety standards and fuel quality on all levels of aircraft operators, pilots, fuel suppliers, fuel storage managers and persons fuelling aircraft.

This AC supplements the regulations by providing further guidance for persons involved in the fuelling of aircraft.

For further information

For further information, contact CASA's Operations Standards (telephone 131 757).

Status

This version of the AC is approved by the Branch Manager, Flight Standards.

Note: Changes made in the current version are annotated with change bars.

Version	Date	Details
v1.1	August 2023	Added the critical fuelling point definition from the CASR Dictionary, revised the fuelling zone definition used only in this AC, removed the fuelling area definition used only in this AC, clarified and reintroduced pre-existing CAO 20.9 fuelling distances. Other editorial amendments to clarify the regulatory requirements related to fuelling.
v1.0	November 2021	Initial AC.

Unless specified otherwise, all subregulations, regulations, Divisions, Subparts and Parts referenced in this AC are references to the *Civil Aviation Safety Regulations 1998 (CASR)*.

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1 Reference material

1.1 Acronyms

The acronyms and abbreviations used in this AC are listed in the table below.

Acronym	Description
AC	advisory circular
AFM	aircraft flight manual
AVGAS	aviation gasoline
CAR	*Civil Aviation Regulations 1988*
CASA	Civil Aviation Safety Authority
CASR	*Civil Aviation Safety Regulations 1998*
Jet A-1	*Aviation turbine fuel similar to kerosene*
PIC	pilot in command

1.2 Definitions

Terms that have specific meaning within this AC are defined in the table below. Where definitions from the Regulations have been reproduced for ease of reference, these are identified by grey shading. Should there be a discrepancy between a definition given in this AC and the Regulations, the definition in the Regulations prevails.

Term	Definition
Bonding	The process of ensuring the fuel supply source is at an equal electrical and static potential as the aircraft
Critical fuelling points	for fuelling an aircraft, means any of the following: a. a fuel tank filling point on the aircraft; b. a fuel tank vent outlet on the aircraft; c. the ground fuelling equipment that is used to fuel the aircraft. **Note:** This definition therefore includes any fill points or vent points in the fuelling system and any ground equipment used for fuelling, such as hydrants and associated vent, fuel vehicles / tankers and associated vent, aircraft fill points and aircraft fuel tank vents.
Fuelling	includes fuelling and defuelling. **Note:** This means both supplying an aircraft with fuel and defuelling an aircraft.
Fuelling zone	An area extending 6 m radially from all critical fuelling points. Noting that when multiple critical fuelling points exist they may overlap and form a larger combined fuelling zone(s).

1.3 References

Legislation

Legislation is available on the Federal Register of Legislation website https://www.legislation.gov.au/

Document	Title
Division 91.D.6 of CASR	Fuel requirements
Regulation 138.300 of CASR	Hot fuelling
Regulation 121.240 of CASR	Fuelling safety procedures
Regulation 133.195 of CASR	Fuelling safety procedures
Regulation 135.220 of CASR	Fuelling safety procedures
Regulation 138.302 of CASR	Fuelling safety procedures

Advisory material

CASA's guidance material is available at https://www.casa.gov.au/publications-and-resources/guidance-materials

Document	Title
AC 91-15 v1.1	Guidelines for aircraft fuel requirements

Other material

International Civil Aviation Organization (ICAO) documents are available for purchase from http://store1.icao.int/

Document	Title
ICAO Doc 9261	Heliport Manual
ICAO Annex 6 Part III	International Operations - Helicopters
UK CAA CAP 74	Aircraft Fuelling: Fire Prevention and Safety Measures
UK CAA CAP 437	Offshore Helicopter Landing Areas: Guidance on Standards

2 General

2.1.1 The AC is intended to give guidance to aerodrome authorities, aircraft operators and fuelling organisations for the fuelling[1] of aircraft. Much of the guidance will also apply to the fuelling of aircraft on water, and to the precautions to be taken during maintenance of aircraft fuel systems, but supplementary instructions will generally be necessary to provide for these cases.

2.1.2 Reference should also be made to the relevant Australian Standards applicable to the storage and handling of fuel and to associated guidance material.

2.1.3 This AC discusses elements of fuel and oil safety and provides guidance on safe operating practices, namely:

- identification and determination of fuel quality and type
- hazards associated with aircraft fuels
- safety precautions during fuelling.

2.1.4 Incorrect or contaminated fuel can cause aircraft accidents and in-flight incidents. Aircraft fuellers, operators, pilots, maintenance staff and operational personnel must be familiar with the fuel and oil requirements of the models and types of aircraft they are dealing with.

2.1.5 Aircraft fuels are hazardous substances and require careful storage and dispensing to reduce the risk of fire or explosion.

2.1.6 Aircraft fuelling operations pose safety risks that require appropriate management by all persons involved in the process.

2.1.7 This AC provides guidance which outlines the risks involved, and accepted methods of reducing those risks to as low as practicable.

[1] See the definition of fuelling. Fuelling includes both the activity of refuelling an aircraft and defuelling an aircraft.

3 Fuels and oils

3.1.1 Aircraft engines are designed to use a specific grade of fuel and oil. Use of an incorrect or unapproved fuel or oil can cause power loss or engine failure, or drastically reduce the service life of the engine.

3.1.2 The specification and grade of aviation fuel and aircraft engine lubricating oil, aircraft engine power augmentation fluid and aircraft hydraulic system(s) fluid specified for a particular purpose is listed in the aircraft flight manual (AFM), or in other manuals provided by the aircraft or aircraft engine manufacturer.

3.1.3 Regulation 91.465 of CASR places the responsibility on the pilot and the operator to ensure the aircraft is fuelled with the correct type and grade of fuel that is uncontaminated. The regulation also extends to requiring any person supplying fuel to an aircraft to ensure the fuel is correct and uncontaminated.

CAUTION: Use only the grades of fuel and oil that have been approved by the engine manufacturer.

3.2 Aircraft engine oil

3.2.1 The four basic functions of engine oil are to:

- lubricate
- cool
- clean
- seal.

3.2.2 The wrong type of oil, or insufficient oil supply, will interfere with any, or all, of the basic oil functions, and is likely to cause serious engine damage and eventual failure. Inappropriate oil additives may harm an engine and should therefore not be used unless the additive has been specifically approved for the type of engine.

3.2.3 Modern automotive oils are designed for low-temperature water-cooled engines and are required to minimise atmospheric pollution. The use of current grades of automotive oils in air-cooled piston and turbine engines is not recommended and is almost certain to reduce engine service life. Use the grade of aircraft engine oil recommended for the engine, and if it is not immediately available, do not fly the aircraft unless an appropriately qualified engineer can identify another grade acceptable to the engine manufacturer.

3.2.4 Always double-check the oil filler cap and dipstick to ensure they are secure before every flight and after adding oil or checking the oil level. If the oil filler cap or dipstick is left off, or comes off in flight, oil is likely to flow across the engine and its cowling, leading to fire hazard, likelihood of engine failure, and in the case of single-engine aircraft, loss of visibility.

3.2.5 Regulation 91.460 of CASR requires the pilot in command (PIC) of an aircraft to carry sufficient oil to complete the flight safely.

3.3 Automotive gasoline in aircraft engines

3.3.1 Automotive gasoline can be used only in aircraft which have been issued supplemental type certificates (STCs) authorising the use of automotive gasoline. If automotive gasoline is permitted, it must be used strictly in accordance with the conditions specified in the aircraft flight manual or approved alternative.

3.3.2 Notwithstanding the existence of STCs authorising the use of automotive gasoline in certain aircraft engines, fuel suppliers generally reserve the right to withhold supply of automotive gasoline known to be destined for aviation because of the difficulty of ensuring an appropriate level of quality control in the supply system. Generally, the quality control system in place for aviation gasoline is far more stringent than that for motor gasolines. Aviation gasoline is kept well segregated from other products to ensure its unique properties are protected, and to prevent exposure to contaminates including water. In addition, there are extensive procedures and facilities to continually remove any traces of dirt, water or other contaminants that might appear during distribution. In this way, supply of aviation gasoline into aircraft is considered to be clean, dry and to the correct specification.

3.3.3 Automotive fuels can contain varying amounts of ethanol. The presence of ethanol can seriously affect aircraft fuel system components unless they are designed specifically for ethanol exposure. Consult the aircraft and engine manufacturers information for advice on whether fuels of this type can be used.

3.3.4 The octane rating specified by the engine manufacturer is the minimum that can be used in the particular engine without damaging it. AVGAS of a higher octane rating could be safely used, although higher octane ratings contain higher amounts of lead which can cause lead fouling of spark plugs. The problem of lead fouling can be minimised by careful fuel management, by leaning mixture in accordance with flight manual instructions in flight, and especially, by more frequent spark plug maintenance.

3.3.5 Currently fuel for civil aviation is being produced in three grades and colours, and to assist in identification of fuel grades, coloured dyes are used as follows:

- AVGAS 100 - green
- AVGAS 100LL (Low-Lead) - blue
- Jet A1 turbine fuel - colourless or straw-coloured.

3.3.6 As described in paragraph 3.1.3 of this AC, regulation 91.465 of CASR requires the:

- PIC and the operator of an aircraft to ensure that the aircraft is not fuelled with contaminated, degraded or inappropriate fuel
- fuel supplier to ensure that the aircraft is not supplied with contaminated, degraded or inappropriate fuel
- persons conducting the fuelling to ensure that the aircraft is not fuelled with contaminated, degraded or inappropriate fuel.

4 Water contamination

4.1.1 Water manifests itself in aviation fuels in three forms:

- dissolved water, which converts to free water droplets when the fuel temperature decreases
- suspended water, which appears in the form of droplets that reflect light, with high concentration of droplets causing the fuel to have a cloudy or hazy appearance
- free water, which can arise from condensation inside an aircraft's tanks or inside a storage tank, leakage into a cracked underground storage tank, leakage past filler cap seals/O-rings on aircraft or storage tanks, or the coalescing of suspended water droplets from within a fuel mass.

4.1.2 Condensation contamination is the precipitation of free water from air inside fuel tanks, either used for ground storage or within the aircraft itself. It occurs on the inside of a partially filled fuel tank when relatively warm moist air above the fuel encounters a cold inside surface of the tank, such as on a descent, or while standing on a cool night. Standing the aircraft overnight with only partially filled fuel tanks will increase the amount of air space and hence water vapour in the tanks, and therefore increase condensation precipitation. Condensation during descent cannot be prevented but standing or storing the aircraft with full tanks will minimise the volume of air and hence precipitation of free water while the aircraft is on the ground (provided structural limitations allow this - check the aircraft manufacturer's advice).

4.1.3 The PIC is responsible for checking that there is no free water in the fuel (see paragraph 3.1.3 of this AC). It is recommended as a minimum, that the aircraft be checked prior to the first flight of the day, after each fuelling, and always after taking on board fuel that has potential to be contaminated with water. It is also recommended that the aircraft fuel tank(s) and sumps be sampled before fuelling to remove condensation contamination from undisturbed fuel, especially if the aircraft has been parked in the open on a cool night.

4.1.4 Checking for water immediately after fuelling may not identify the presence of contaminates, because the agitating action of fuel entering the tank may disperse water and other contaminants, which can remain suspended for many minutes and may not separate out until the aircraft is airborne.

4.1.5 When possible, allow for adequate settling time before testing for water. As a guide, the minimum settling time for aviation gasoline is 15 min per 300 mm depth of fuel and 60 mins per 300 mm depth of turbine fuel.

4.1.6 It is important to know where all the fuel drains on the aircraft are located. Draining from the lowest point is essential, although the lowest point drains may well be the most awkward to find if the design does not bring that part of the fuel system close to the aircraft skin.

4.1.7 Some aircraft have fuel tank installations where the lowest point of the system can be affected by the attitude of the aircraft when parked. Additionally, some bladder type tanks can suffer from folding of the bladder which can act to trap water away from the drain point. Special procedures may be published by manufacturers or operators to overcome these limitations.

4.1.8 Persons involved with fuelling an aircraft must endeavour to confirm that the fuel has been checked for the presence of water prior to transfer. This essential precaution is particularly difficult when fuelling from drum stocks, where it is sometimes hard to ensure that the sample is taken from the exact lowest point of the drum. If a sample cannot be taken from undisturbed fuel it is necessary to use a testing method such as water-detecting paste, proprietary capsules or testing paper. Sensory perceptions of colour and smell, if used alone, are unreliable. All fuel must be free of suspended water and other contaminating matter before it is placed in the aircraft tanks.

Note: Attention is drawn to the special (high) standards of filtration specified by the manufacturers of certain types of engines, i.e. turbine engines and direct-injection piston engines.

4.1.9 In the case of Jet A1 turbine fuel, suspended water droplets may cause a fuel sample to appear cloudy, but the only sure way of detecting suspended water is by testing a sample with water-detecting paste, proprietary capsules or testing paper.

4.1.10 Micro-organisms can grow in Jet A1 in the presence of water and when this occurs, will appear as a soapy, slippery slime on the inside surfaces of fuel tanks, or dark-coloured contamination at drain points. Bacteria and fungal micro-organisms may cause serious corrosion in integral fuel tanks, as well as clogging fuel filters, screens, and fuel control units. Tanks holding Jet A1 should be regularly checked for the presence of slime and corrosion.

4.1.11 Biocides may be used in permitted concentrations in storage tanks and aircraft tanks to reduce the incidence if biological contaminants. Manufacturers' dosage instructions are critical in ensuring these products do not pose additional hazards.

Note: Modern aviation fuel storage facilities are designed with a significant slope to a water collection sump which enables ready removal of water, thus minimising any potential growth in Jet A1.

5 Incorrect fuel

5.1.1 Contamination with the wrong types or grades of fuel can cause aircraft fuel system or engine damage, and possible engine power loss or failure in flight:

- If aviation gasoline is contaminated with turbine fuel its antiknock and volatility characteristics will be inadequate for reciprocating engines.
- If turbine fuel is mixed with aviation gasoline damaging lead deposits may accumulate in a turbine engine, unless the mix is used strictly in accordance with instructions from the engine manufacturer.

5.1.2 While most turbine engines can operate on AVGAS (usually with limitations and extra service required by the engine manufacturer), Jet A1 in a gasoline engine will cause total failure or severe degradation of performance. If fuel of the wrong specification is placed in an aircraft's tanks, the fact must always be entered in the maintenance release. Appropriate corrective action must be carried out before the engine(s) are operated.

5.1.3 To minimise the chance of incorrect fuel being placed in an aircraft, owners are required to affix appropriate decals adjacent to the fill points, to avoid expensive engine repair bills or catastrophic engine failures.

5.1.4 A fuel industry recommendation for further reducing the chance of having the wrong fuel delivered to an aircraft is to install different sized fuel tank orifices for different fuels, as is done for automotive gasolines. The fuel industry recommendation is to have Jet A-1 transferred via a 70 mm nozzle through a 75 mm port, while AVGAS would be transferred via a 49 mm nozzle through a 60 mm port. The orifice difference would ensure that a Jet A1 fuel hose nozzle would not fit into a AVGAS tank filler hole. Most aircraft manufacturers have service bulletins dealing with this issue, and universal adaptors are available.

5.1.5 As described in paragraph 3.1.3 of this AC, regulation 91.465 of CASR requires the:

- PIC and the operator of an aircraft to ensure that the aircraft is not fuelled with contaminated, degraded or inappropriate fuel
- fuel supplier to ensure that the aircraft is not supplied with contaminated, degraded or inappropriate fuel
- persons conducting the fuelling to ensure that the aircraft is not fuelled with contaminated, degraded or inappropriate fuel.

5.1.6

CAUTION: Don't put the wrong fuel in an aircraft. Jet A-1 in an AVGAS engine will cause rough running and a significant loss of power and may cause a total engine failure.

AVGAS in a turbine engine may reduce engine operating life.

6 Caps and vents

6.1.1 In-flight fuel loss by siphoning overboard is primarily attributed to poor maintenance and service practices. Siphoning overboard can be traced to problems such as fuel filler caps incorrectly installed and/or worn fuel filler caps and gaskets. Always check the condition of fuel filler cap O-rings, gaskets, pawls, and springs for evidence of wear and/or deterioration. Deformed or worn pawls may affect the sealing effectiveness of the O-rings or gasket. Similarly, a tank-cap attachment chain or lanyard can be trapped across the seal and defeat its purpose.

6.1.2 Pilots should know where and how the aircraft fuel system and/or cap is vented. Fuel venting systems are installed in different ways, but the most common arrangement is a venting tube extending from the aircraft in such a manner as to assure adequate fuel cell venting. If the tube is bent, distorted, or kinked, it is highly possible that partial or complete stoppage of fuel flow will occur. When the vent is completely blocked, (possibly by insects such as mud wasps building nests in vent tubes), collapse of the fuel cell could occur, followed by engine stoppage.

6.1.3 Some aircraft have a forward facing vent tube built into the fuel filler cap to provide ram-air pressure in the tank. Should this type of cap be incorrectly fitted, with the tube facing rearward, fuel flow difficulty or siphoning may occur because of low pressure in the tank from the absence of ram air pressure and the reduced pressure further aft over the upper surface of the wing.

6.1.4 Some fuel systems have a small vent hole in the fuel cap. Fuel flow stoppage may occur if a vented cap is replaced by a non-vented type. Replacement fuel caps must be of a type approved for the aircraft. Fuel filler caps are not usually interchangeable between aircraft because designs vary between airframe manufacturers and even between models of the same make.

6.1.5 Fuel bladders will collapse if blocked vents do not allow air to flow into the tank to replace fuel as it is used. Insufficient venting may cause collapse of a bladder during descent into denser atmosphere. Tank collapse may also result from incorrect installation, or failure of the system used to fix the bladder to the surrounding structure. If the fuel gauge apparatus is in the vicinity of the pump and surrounded by relatively solid structure it may not be immediately affected by a tank collapse and could continue to give readings that may at first appear to be credible. It is possible for the indications to temporarily suggest a very low rate of usage or even show a transitory increase in the quantity of fuel in the tank. Whatever the cause or manner of fuel bladder collapse, a dangerous situation will result.

CAUTION: Fuel bladder collapse may exaggerate indications of fuel in the tank.

6.1.6 If the fuel used from a particular tank seems to be significantly less than expected, and an assessment of the prevailing operational factors does not reveal a reason, it may be that the fuel bladder has collapsed and if in doubt proceed on the presumption that you could run out of fuel in the tank without warning. Crumpling of the bladder could block some fuel from reaching the engine.

6.1.7 If an in-flight fuel consumption check reveals possible inconsistencies with indicated fuel levels and expected consumption, proceed in accordance with the requirements outlined in the MOS applicable to the kind of operation being conducted[2] and associated AC 91-15 - guidelines for aircraft fuel requirements, or in accordance with the exposition or operations manual as applicable. This may involve diversion or landing as soon as practicable to determine the reason for the disparity.

6.1.8 If these issues are experienced, make sure indications and observations of the problem are entered in the maintenance release at the completion of the flight.

[2] Either the Part 91 MOS, Part 121 MOS, Part 133 MOS or Part 135 MOS depending on the kind of operation being conducted.

7 Anti-icing additives

7.1.1 Certain turbine engine powered aircraft require the use of fuel containing anti-icing additives. Pilots should ensure that fuel orders to fuelling companies include the instruction to supply fuel with the additive included if required.

7.1.2 If fuelling from installations where the additive must be added manually, the additive manufacturers' instructions must be followed to assure proper concentration and appropriate safety precautions are followed.

CAUTION: Anti-icing additives are hazardous (carcinogenic) substances and are therefore subject to specific handling procedures.

8 Why fuel is dangerous to handle

8.1.1 AVGAS is highly volatile, because it changes from a solid (liquid) to a vapour state at a temperature usually much lower than room temperature.

8.1.2 It is easy to observe the difference between the volatility of various fuels. If AVGAS is splashed on a non-absorbent surface it soon evaporates, whereas the same amount of turbine fuel will take longer to disappear. Diesel fuel will take even more time to evaporate. The time a given fuel takes to evaporate is an indication of its volatility, which governs its tendency to form an explosive mixture in the atmosphere.

8.1.3 Left to its own devices fuel vapour and air (oxygen) will combine to form an explosive mixture more than comparable to an equivalent mass of dynamite.

8.1.4 One way that we can create an explosive mixture of free fuel in the air is by splashing a volatile fuel in an open container, as in washing oily components, or by pouring fuel from a sample bucket into another open container.

8.1.5 Just a small spark or a hot surface can initiate a fuel explosion.

8.1.6 An electrostatic charge may accumulate on the surface of the aircraft or fuelling vehicle when conditions are favourable. It may also be generated by the process of fuelling.

8.1.7 The "arcing" of any residual electrostatic charge between the aircraft and fuelling vehicle can result in a spark sufficient to ignite fuel vapour. Ensuring that the aircraft is bonded to the fuelling equipment so that the two cannot have a difference in electrical potential can eliminate the hazard of sparking in the presence of fuel.

8.1.8 Before the aircraft's tank is opened, bond the aircraft and fuelling equipment by connecting a conductor between designated points on clean and unpainted metal surfaces of both the aircraft and the fuelling equipment. This bonding process is explained in more detail in section 12.11 of this AC.

8.1.9 As described in section 13.11 of this AC, regulation 91.480 of CASR requires the person fuelling the aircraft to ensure the aircraft is electrically bonded to the fuelling equipment.

9 Fuelling of aircraft

9.1.1 Multiple persons have responsibilities in relation to the fuelling of aircraft. Significant requirements include the following:

- A PIC, and in some cases the operator, are responsible for determining the usable fuel on board the aircraft before a flight[3]
- Australian air transport operators and aerial work operators are required to include fuelling safety procedures in their exposition or operations manual[4]
- The operator, PIC, fuel supplier and persons fuelling the aircraft also have responsibilities relating to ensuring that the fuel is not contaminated and is the appropriate grade (see paragraph 5.1.5 of this AC).

9.1.2 Persons fuelling an aircraft must check before fuelling that:

- the fuel type and grade and the additives in the fuel are correct for the aircraft
- the fuel has been checked for water and other contaminants
- the aircraft is bonded to fuelling equipment.

Notes:

1. This bond is essential and must be maintained throughout the fuelling operation. The bonding connections should not be removed until all fuel caps have been replaced.
2. Conductive type fuel hoses do not provide a satisfactory method of bonding.

9.1.3 When carrying out over-wing fuelling:

- feed the fuel filler hose across the wing leading edge (otherwise lightly structured flaps, ailerons and trailing edge may be damaged)
- use a rubber mat to protect wing surfaces
- pay particular attention to leading edge de-icing boots and avoid damage to these surfaces
- avoid standing on wing surfaces or struts
- hold the fuel nozzle firmly while it is inserted in the fuel tank filler neck (don’t let the nozzle twist or distort the fuel orifice, or strike the bladder or the lower skin of the tank)
- replace and secure fuel filler caps.

9.1.4 Persons carrying out over-wing fuelling should take care to remove objects such as pens or coins from shirt pockets. If an object falls into a fuel tank maintenance action is required before flight.

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[3] For an operation that is not an Australian air transport operation, this requirement is placed on the PIC by subsection 19.05(1) of the Part 91 Manual of Standards (MOS). For an Australian air transport operation, this requirement is placed on the operator and the PIC by the relevant subsections of the Part 121, 133 and 135 MOS.
[4] This requirement is placed on an Australian air transport operator by regulations 121.240, 133.195 and 135.220 of CASR, and is placed on an aerial work operator by regulation 138.302 of CASR.

10 Fuel transfer in hangers

10.1.1 During major servicing it may be necessary on occasions to fuel or defuel immobilised turbine aircraft in a hangar.

> **CAUTION: The only fuel that should be ROUTINELY transferred in a hangar is Jet A1 — TRANSFER OF AVIATION gasoline in a hangar IS DANGEROUS, AND CAN ONLY BE DONE SAFELY UNDER EXCEPTIONALLY STRICT SAFETY PROCEDURES.**
>
> **Be aware that the major fuelling companies do not approve of the transfer of AVGAS in a hangar.**

10.1.2 Should it be necessary to transfer fuel in a hangar, close supervision must be established and maintained throughout the operation. All sparking hazards must be rigorously eliminated, all occupants of the hangar must be warned of the work, and ideally, fire services should be alerted. In order to reduce fuel vapour levels and to facilitate any required emergency evacuation or response, the operation should be undertaken with the hangar doors open with fuel lines routed via the open doors. Aerodrome authorities, aircraft maintenance organisations and fuelling companies should promulgate agreed procedures to cover 'in hangar' fuelling.

10.1.3 The aerodrome operator, aircraft maintenance organisations and fuelling companies should have agreed procedures describing ‘in hangar’ fuelling. These procedures should cover the following:

- In the absence of a fixed automatic fire protection system capable of dealing with a fuel fire the Aerodrome or company Fire Service should standby throughout the transfer of fuel.
- The operation must be in accordance with a written procedure, agreed between fuel supplier and customer.
- Approval must be obtained from the airport authority.
- All personnel involved must be given specific training in the transfer procedures and relevant safety precautions.
- Special attention must be given to the avoidance of the build-up of fuel vapour.
- In order to prevent the automatic venting of aircraft fuel tanks, not more than 25% of the total aircraft fuel tank capacity should be uplifted. Only the minimum amount required to perform the task should be transferred.
- A fuelling overseer should be positioned inside the hangar in full view of the fuelling hose and aircraft and in a position to immediately communicate with the fuelling vehicle operator.
- A fuelling vehicle operator should be positioned outside the hangar adjacent to the fuelling vehicle controls, and in a position to communicate immediately with the fuelling overseer.

Note: The above operations should only be permitted when it is impracticable to fuel/defuel outside the hangar. it should only be permitted for fuel calibrations during major checks or fitment and testing of fuel tank booster pumps, balance pipes, fuel leak tests and other minor assembly work.

10.1.4 In hangar fuelling should not be permitted for the purposes of tank overspill tests, dump valve tests or normal fuelling of the aircraft. Readers of this AC are reminded that regulatory requirements for bonding and earthing are contained in regulation 91.480 of CASR (for more information see section 13.11 of this AC).

10.1.5 All fuel hoses should have self-sealing couplings with all couplings (except the direct aircraft connection) outside the hangar. Hose pressure testing records should be available for scrutiny prior to commencement of fuelling/defuelling inside hangars.

11 Ground venting

11.1.1 An important part of fire prevention is to avoid situations where fuels are dispersed as aerosols, which are quickly transformed into a dangerous vapour. Tank overflows on the ground from fuel vents is particularly dangerous because the fuel tends to disperse as droplets, which vaporise into an explosive mixture in the vicinity of the aircraft.

11.1.2 For this reason, it is particularly important that persons fuelling aircraft do not fill the tanks to the point where fuel is likely to overflow from the fuel vents in the circumstances prevailing at the time of fuelling, or which can reasonably be anticipated before flight.

12 Fire prevention and safety measures

12.1 General

12.1.1 The aerodrome operator, aircraft operator, PIC and the person responsible for fuelling each have responsibilities in respect of the safety measures to be taken during fuelling operations[5].

12.1.2 It is important to note that the information in this section of the AC is not intended to replace the operating procedures for the person responsible for fuelling or the fuelling organisation which are usually developed to meet the requirements imposed by special equipment, or other regulations, etc.

Note: The use of the term *fuelling* in this publication embraces both fuelling and defuelling. The draining of a small amount of fuel for checking purposes is not considered fuelling.

12.2 Fuelling vehicles

12.2.1 All fuelling vehicles, hydrant dispensers and their components should conform to relevant Australian Standards and Fuelling Company recommended safety standards.

12.3 Fuelling area

12.3.1 If no specific aerodrome operator guidance exists, the following guidelines are recommended to be applied:

- The fuelling area should normally be out in the open air and should be an area approved by the aerodrome operator
- The fuelling area should normally be sited so that the aircraft can be moved from the fuelling installation in the event of a spill, unless the fuelling equipment is portable.

12.4 Fuelling distances

12.4.1 If no specific aerodrome operator guidance exists, the following guidelines are recommended to be applied. During fuelling operations (fuelling or defuelling) all critical fuelling points should be kept a minimum of:

- 5 m from a sealed building, other than those parts constructed for the purpose of direct loading or unloading of aircraft, such as nose loaders, aerobridges etc
- 6 m from any other aircraft or vehicle not used for fuelling, stationary or otherwise
- 15 m from any unsealed building, other than those parts constructed for the purpose of direct loading or unloading of aircraft, such as nose loaders, aerobridges etc
- 15 m from any exposed public area, other than those parts constructed for the purpose of direct loading or unloading of aircraft, such as nose loaders, aerobridges etc.

[5] See the Part 139 MOS for aerodrome operator requirements. See Part 91 of CASR for PIC, fuelling supplier and refueller requirements. See Parts 121, 133, 135 and 138 of CASR for Australian air transport operator and aerial work operator requirements.

Note: These distances were sourced from old rules previously mandated by Civil Aviation Order 20.9, but which are now no longer legally mandatory. However, they remain appropriate guidelines that can be used in the absence of specific aerodrome operator guidance.

12.4.2 Regulation 91.470 of CASR requires a distance of 15 m between any fire hazard and the aircraft or equipment used for fuelling. The person fuelling and any person creating a fire hazard are responsible for ensuring this rule is met.

12.4.3 Regulation 91.485 of CASR requires a distance of 15 m between an electronic device and a critical fuelling point. The person fuelling and any person with an electronic device are responsible for ensuring this rule is met. There are some exceptions to this rule listed in subregulation 91.485(3) of CASR.

13 Precautions prior to fuelling

13.1 Aerodrome fire service

13.1.1 All personnel involved in the fuelling of aircraft should be familiar with the procedure for summoning the Aerodrome Rescue and Fire Fighting Service or local fire brigade and (if provided) the fuel hydrant emergency shutdown system.

13.2 Fire extinguishers

13.2.1 Regulation 91.475 of CASR requires that the person fuelling is responsible to ensure that appropriate firefighting equipment is readily available for use during fuelling. This means:

- fire extinguishers of the right type and capacity
- located on fuelling equipment or between 6 m to 15 m from the fuelling point
- fire extinguishers in a fully serviceable condition (ensured by regular inspection and maintenance in accordance with the relevant Australian Standards)
- fuelling personnel have been instructed in the use of any extinguisher
- at least one (for hot air balloons) or two (for all other aircraft).

13.2.2 Fire extinguishers may remain on the fuelling vehicle(s) provided they are stowed in quick release housings.

13.3 Fire warnings

13.3.1 When an aircraft is displaying a fire or engine overheat warning on the flight deck, the flight crew should warn the person responsible for fuelling that fuelling should not begin until the cause of the warning has been established and the appropriate action taken to ensure that fuelling can be safely carried out.

13.4 Overheated undercarriage assemblies

13.4.1 The airline or aircraft operator should ensure that when any part of an aircraft undercarriage, e.g. wheels, tyres or brakes appear abnormally hot, the Aerodrome Rescue and Fire Fighting Service is called. Fuelling should not take place until the heat has dissipated and the Aerodrome Rescue and Fire Fighting Service confirms that it is safe to proceed. Fuelling equipment should not be positioned at an aircraft until the Fuelling Overseer (see below) is advised that no risk remains.

Note: In checking for high temperatures, care should be taken in approaching the wheels. Approach only from the front and rear, never from the sides.

13.5 Supervision of fuelling

13.5.1 Operators should appoint a competent person to supervise fuelling operations. For simple, single pilot operations this would normally be the pilot-in-command. The pilot should ensure that fuelling operations conform to the guidance provided in the aircraft flight manual, exposition, or operations manual if relevant to their operation and this circular.

13.5.2 Larger or more complex operations may appoint a person to supervise fuelling (referred to here as the Fuelling Overseer) to ensure the observance of correct fuelling procedures and for liaison with the fuel company's fuelling operatives. Such a person may be a maintenance engineer, crew member or other person instructed in the requirements of the supervisory task. The fuelling overseer should identify themself to the fuelling company operator so that there is an obvious contact if a problem occurs.

13.5.3 The fuelling overseer should ensure that there is adequate restraint of the aircraft by checking that the wheels are adequately chocked or that an acceptable alternative is in place.

13.5.4 The fuelling overseer should remain in the vicinity of the aircraft whilst fuelling operations are in progress and should ensure the correct positioning of service equipment and fuelling vehicles.

13.6 Clear exit paths

13.6.1 The pilot or fuelling overseer should ensure that a clear path is maintained from the aircraft to allow for the quick removal of fuelling vehicles and equipment. Fuelling equipment should be positioned so that there is no requirement for vehicles to reverse before departure. All vehicles and equipment should be positioned to allow the unobstructed exit of persons from the aircraft in an emergency.

13.7 Manning of fuel vehicles

13.7.1 Every vehicle used for carrying fuel or acting as a dispenser, except when parked in a place designated for the purpose, should be constantly under the control of at least one competent person.

13.7.2 Only properly trained personnel should be permitted to operate the equipment and they should be used in sufficient numbers to ensure that the fuel flow can be cut off quickly in an emergency

13.8 Fuelling zone precautions

13.8.1 During fuelling operations, air and fuel vapour are displaced from the aircraft fuel tanks. This potentially explosive vapour is expelled via vent points.

13.8.2 Within the fuelling zone, as well as up to 15 m from a critical fuelling point, smoking and the use of naked lights are prohibited[6]. Personnel working within the fuelling zone and those engaged in fuelling should not carry matches or other means of ignition and ensure footwear is of the non-sparking type approved for fuelling operations.

13.8.3 Portable electronic devices that have a capacity of transmitting electromagnetic energy and the operation of switches on lighting systems of other than intrinsically safe types

[6] See regulation 91.470 of CASR. For naked lights, this assumes that they present a fire hazard.

are forbidden by regulation 91.485 of CASR unless an exception stated in that rule applies.

13.8.4 Only authorised persons and vehicles should be permitted within the fuelling zone and the numbers of these should be kept to a minimum. Passengers should not be allowed within the fuelling zone and baggage/passenger-reconciliation checks should be carried out away from the fuelling zone.

13.8.5 Unless fuelling takes place in a designated No Smoking Area, 'No Smoking' signs should be displayed not less than 15 m from the fuelling equipment and the aircraft.

13.8.6 Aircraft-borne Auxiliary Power Units (APUs), which have an exhaust efflux discharging into the fuelling zone, should, if required to be in operation during fuelling, be started before filler caps are removed or fuelling connections made.

13.8.7 Ground Power Units (GPUs) may be operated provided they are positioned not less than 6 metres from critical fuelling points when in use.

13.8.8 Equipment with all-metal wheels or metal studded tyres capable of producing sparks should not be moved in the fuelling zone whilst fuelling is in progress.

13.8.9 The airline or aircraft operator should ensure that all personnel working on, inside or in the immediate vicinity of the aircraft are made aware that fuelling is taking place.

13.8.10 All hand torches and inspection lamps and their cable connections used within the fuelling zone should be certified for use in such an environment or 'Intrinsically Safe.'

13.8.11 Vehicle engines should not be left running unnecessarily in the fuelling zones.

13.8.12 Photographic flash bulbs or electronic flash equipment should not be used within 6 metres of the fuelling equipment or any filling or venting points of the aircraft.

13.9 Hazards from adjacent aircraft operations

13.9.1 Before and during fuelling the person responsible for fuelling should ensure that no hazard arises to the personnel or equipment, including such hazards as efflux from other aircraft or APUs. If the person responsible for fuelling considers that a hazard exists fuelling should be stopped immediately until conditions permit resumption.

Note: The engine efflux of modern jet aircraft when taxiing can have a speed of up to 65 knots and a temperature of approximately 520°C at a distance of 30 m from the jet pipe. This may not be dangerous from a fire point of view, but the blast could be dangerous to aircraft, personnel and equipment.

13.10 Operation of radar

13.10.1 Aircraft should not be fuelled within 30 m of radar or HF radio equipment under test in aircraft or ground installations.

13.11 Bonding

13.11.1 During fuelling, the prevention of fire risks due to static electricity discharge is dependent upon effective bonding between the aircraft and the fuel supply source.

13.11.2 All connections between ground equipment and the aircraft should be made before filler caps are removed and not broken until the filler caps have been replaced.

13.11.3 The aircraft, fuelling vehicle, hose coupling or nozzle, filters, funnels or any other appliance through which fuel passes, should be effectively bonded to each other throughout the fuelling operation. Connection should be made to designated points or to clean unpainted metal surfaces of the aircraft and fuelling vehicles. Plastic fuel containers, unless specifically designed to have anti-static properties, should not be used to transport or move fuel around airfields for the purpose of filling aircraft, as the sloshing of fuel can allow electro-static charge to build up.

13.11.4 Plastic filler funnels or pipes should **NEVER** be used to guide fuel into aircraft tanks — Where appropriate it is recommended that a metal container and funnel is used. If necessary make up a proper bonding device from copper braid and heavy duty crocodile clips. The funnel and fuel container must be bonded.

Note: Unless approved bonding points are provided bonding clamps should never be attached to landing gear or highly stressed components as this may result in serious damage.

13.11.5 Before the transfer of fuel commences bonding should be carried out as follows:

- the aircraft should be effectively bonded to the fuelling equipment. (Reliance must not be placed upon conductive hoses for effective bonding and only dedicated clips and wires provided for this specific purpose should be used.)
- prior to over-wing fuelling the nozzle of the hose should be bonded to the aircraft structure before removing the tank filler cap
- with underwing pressure fuelling, the mechanical metal to metal contact between the aircraft fitting and the nozzle eliminates the need for a separate hose-end bonding cable
- any cable, clips and plugs for bonding should be maintained in good condition and regularly tested for electrical continuity
- when fuelling from hand operated equipment including pumping from cans or drums, similar precautions should be taken to bond the pumping equipment, hose nozzle and containers. if funnels are used they should be bonded both to the nozzle of the hose or can and to the aircraft using wires provided for this specific purpose.

Note: On no account should either the fuelling vehicle or the aircraft be bonded to a fuel hydrant pit.

13.11.6 Regulation 91.480 of CASR requires that the person fuelling an aircraft must ensure that the aircraft is electrically bonded to the equipment used to fuel the aircraft.

14 Precautions during fuelling operations

14.1.1 The following general precautionary measures should be taken during aircraft fuelling operations:

- The main aircraft engine(s) should not be operated. The main aircraft engines should not be used to power the aircraft electrical systems during fuelling.
- Bonding, as appropriate, should be carried out in accordance with section 13.11 of this AC.

14.1.2 Fuelling vehicles and equipment should be positioned so that:

- access to aircraft for rescue and fire fighting vehicles is not obstructed
- a clear route is maintained to allow their rapid removal from the aircraft in an emergency
- they do not obstruct the evacuation routes from occupied portions of the aircraft in the event of fire including chute deployment areas
- sufficient clearance is maintained between the fuelling equipment and the aircraft wing as fuel is transferred
- they are not positioned beneath the wing vents
- there is no requirement for vehicles to reverse before departure.

14.1.3 All other vehicles performing aircraft servicing functions should not be driven or parked under aircraft wings while fuelling is in progress.

14.1.4 All ground equipment such as rostrums, steps etc., should be positioned so that the aircraft settling under the fuel load will not impinge on the equipment.

14.1.5 If an auxiliary power unit located within the fuelling zone or which has an exhaust efflux discharging into the zone is stopped for any reason during a fuelling operation it should not be restarted until the flow of fuel has ceased and there is no risk of igniting fuel vapours.

14.1.6 Aircraft batteries should not be installed or removed, and neither should battery chargers be connected, operated or disconnected.

14.1.7 Connecting and disconnecting ground power generators and the use of battery trolleys to supply power to an aircraft during the fuelling process within the fuelling zone should be prohibited. No aircraft switches, unless of the intrinsically safe type, should be operated during this time. However, connections may be made prior to the start of fuelling and the circuit should then remain unbroken until fuelling has ceased.

14.1.8 No maintenance work, which may create a source of ignition, should be carried out in the fuelling zone.

14.1.9 Oxygen systems should not be replenished.

14.1.10 The Aerodrome Authority - Air Traffic Control should issue guidance, depending on local conditions, as to when fuelling operations should be suspended due to the proximity of severe electrical storms.

14.1.11 Aircraft external lighting and strobe systems should not be operated.

14.1.12 Aircraft combustion heaters should not be used.

14.1.13 Only checking and limited maintenance work should be allowed on radio, radar and electrical equipment. Any use or testing of such equipment should be deferred until fuelling is completed.

14.1.14 When passengers are embarking or disembarking during fuelling their route should avoid the fuelling zone and be under the supervision of an airline official. The use of personal hand held telephones by passengers should be not permitted. The ‘NO SMOKING’ sign should be illuminated throughout fuelling operations and passengers reminded of their responsibilities in this regard.

15 Additional precautions to be taken when passengers remain on board during fuelling operations

Notes:

1. For Part 91 operations in an aircraft using AVGAS, regulation 91.510 of CASR states that passengers are not permitted to be on board during fuelling operations unless either the operator or the PIC holds an approval under regulation 91.045 of CASR.
2. Due to regulation 91.035 of CASR, the restrictions imposed by regulation 91.510 of CASR do not apply if regulation 121.240, 133.195, 135.220 or 138.302 of CASR applies to the operation.

15.1.1 To reduce turnaround time and for security reasons, air transport operators and aerial work operators may allow passengers to embark, disembark or remain on board during fuelling operations.

15.1.2 Operator expositions and operations manuals must detail the procedures used to ensure the safety of passengers and crew during the fuelling operation including the flight and cabin crew briefings and actions.

15.1.3 Whilst fuelling with passengers on board could be safely conducted with aircraft utilising other than a highly volatile fuel, doing so with other fuel types would be unlikely to be safely conducted without significant risk mitigation measures that are detailed in an exposition or operations manual and approved by CASA.

15.1.4 Cabin crew, passengers and other responsible staff should be warned that fuelling will take place and that they must not smoke, operate electrical equipment or other potential sources of ignition.

15.1.5 The aircraft illuminated ‘NO SMOKING’ signs should be on together with sufficient interior lighting to enable emergency exits to be identified. Such lighting should remain on until fuelling operations have been completed. The ‘Fasten Seat Belts’ signs should be switched off and passengers should be briefed to unfasten their seat belts.

15.1.6 Provision should be made, via at least two of the main passenger doors, (or the main passenger door plus one emergency exit when only one main door is available), and preferably at opposing ends of the aircraft, for the safe evacuation of passengers in the event of an emergency. Throughout the fuelling operation a cabin crew should constantly man these doors.

15.1.7 Ground servicing activities and work within the aircraft, such as catering and cleaning should be conducted in such a manner that they do not create a hazard or obstruct exits.

15.1.8 Inside the aircraft cabin the aisles, cross aisles, all exit areas and exit access areas should be kept clear of all obstructions.

15.1.9 Whenever an exit with an inflatable escape slide is designated to meet the requirements of paragraph 15.2.1, the ground area beneath that exit and the slide deployment area should be kept clear of all external obstructions and the fuelling overseer informed accordingly.

15.1.10 Access to and egress from areas where other slides may be deployed should also be kept clear.

15.2 Wide bodied aircraft and all other aircraft equipped with automatic inflatable slides

15.2.1 When a loading bridge is in use no additional sets of aircraft steps need be provided. However, either the left or right rear door should be manned constantly by a cabin crew and should be prepared for immediate use as an emergency escape route using the automatic inflatable slide. Where slide actuation requires the manual fitting of an attachment to the aircraft, e.g., girt bar, the slide should be engaged throughout the fuelling process.

15.2.2 As a precautionary measure when a loading bridge is NOT available for use one set of aircraft passenger steps should be positioned at the opened main passenger door normally used for the embarkation and/or disembarkation of passengers.

15.3 Aircraft not equipped with automatic inflatable slides

15.3.1 When a loading bridge is in use, one set of aircraft steps should be positioned at another opened main passenger door and preferably at the opposing end of the aircraft.

15.3.2 When a loading bridge is NOT available for use, aircraft passenger steps should be positioned at two of the main passenger doors (i.e., preferably one forward and one aft) that are to be open.

15.3.3 Where aircraft are fitted with integral stairways and these are deployed, each may count as one means of egress.

15.4 Cabin crew

15.4.1 Cabin crew or appropriately trained persons are required to supervise passengers and to ensure aisles and emergency doors are unobstructed.

15.4.2 The aircraft operator should at all times ensure that during aircraft fuelling with passengers on board, there are sufficient cabin crew on board the aircraft to enable the rapid safe evacuation of passengers if an incident occurs. In determining the minimum number of cabin crew required, aircraft operators are recommended to take into account the number of passengers on board the aircraft, their location within the cabin, the size of the aircraft and the emergency exits and escape facilities.

15.4.3 If, during fuelling, the presence of fuel vapour is detected in the aircraft interior, or any other hazard arises, the Fuelling Overseer (who should ensure that he/she has adequate means of communication) should be informed. Fuelling should be stopped until, in the opinion of the Fuelling Overseer, it is safe to resume.

15.4.4 Regulation 91.515 of CASR requires that, while non crew members are boarding, on the aircraft or disembarking, if fuel vapour is detected in the aircraft, fuelling must stop. The obligation to comply with this rule is placed on the operator and the PIC.

15.5 Helicopters

15.5.1 Helicopter pressure and gravity fuel inlets and fuel tanks are generally very close to the cabin area. Passengers should not remain in the helicopter whilst fuelling is in progress except in accordance with regulations 133.195 or 138.302 of CASR and an applicable exposition/operations manual. If passengers remain on board during fuelling operations, all main exits should be available for immediate use and the external area adjacent to the exits kept clear. In the case of aircraft where the only normal exit is on the same side as the fill points, then rotors or engine running fuelling with passengers on board is unlikely to be acceptable as a procedure described in an exposition.

Onshore Sites

15.5.2 Fuelling at onshore sites whilst engines/rotors are running should be considered in exceptional circumstances, these may include:

- ambulance and other emergency missions where time is of the essence
- when severe weather conditions make it inadvisable to stop engine/rotors
- operational requirements at the discretion of the PIC.
- circumstances which would require the flight crew to carry out pre-departure checks normally undertaken by an engineer.

15.5.3 If because of the circumstances described in paragraph 15.5.2 above, it is necessary to keep the engines running extreme care should be exercised and the general guidance covering the fuelling area (see section 12.3 of this AC) should be followed. Helicopter operators should ensure that fuelling companies are provided with appropriate written instructions regarding the aircraft and the required safety measures and emergency procedures to be followed.

Offshore sites

15.5.4 In the severe weather and wind conditions such as experienced on offshore rigs/platforms it may be necessary to keep helicopter engines running after landing on the helideck to achieve a quick turn-round and operational reasons may also make it necessary to fuel the helicopter. In such circumstances the PIC of the helicopter should be responsible for the overall direction of the fuelling operation and the operator of the rig/platform should be made aware of the possible hazards, so that they may ensure their helicopter landing officer fully observes the necessary safety precautions.

15.5.5 Fuelling with gasoline or fuelling where wide cut turbine fuels not containing antistatic additive are involved should be prohibited whilst engines are running.

15.5.6 Fuelling with kerosene or with wide cut turbine fuels containing anti-static additive should only be permitted with engine(s) running if the exhaust system is higher than the fuel inlet(s) or on the opposite side of the helicopter.

15.5.7 Fuelling offshore must only be carried out from installations of an approved type. Helicopter operators should always ensure good fire safety practices fuelling takes place, including the provision of rescue and firefighting personnel.

15.5.8 Further guidance on helicopter fuelling may be found in the following documents:

- UK CAP 437: Offshore Helicopter Landing Areas: Guidance on Standards
- ICAO Annex 6 Part Ill, as amended
- ICAO Heliport Manual - Doc. 9261 -AN/903/2, Chapter 6.

15.6 Fuel spillage

15.6.1 In the event of a fuel spillage action should be immediately taken to stop the fuel flow and the aircraft commander/crew informed. The following action may be appropriate although each spillage will need to be treated as an individual case because of such variables as the size and location of spillage, type of fuel involved, prevailing weather conditions, etc.

15.6.2 In the case of a spillage occurring, which measures greater than two metres in diameter, the PIC or fuelling overseer should:

- consider evacuation of the area. It is generally safer upwind and upslope of any fuel spillage
- notify the Aerodrome Rescue and Fire Fighting Service and comply with laid down aerodrome procedures
- prevent the movement of persons or vehicles into the affected area and ensure that all activities in the vicinity are restricted to reduce the risk of ignition.

15.6.3 Engines of vehicles within 6 metres of a spillage should not be started until the area is declared safe.

15.6.4 If a large scale spill occurs, fuel should not be washed into drains or culverts, and every effort should be made to contain and recover the product. In the event of such contamination occurring accidentally, large-scale water flushing should be carried out at once and the local water and environmental authorities notified. Absorbent cleaning agents or emulsion compounds may be used to absorb the spilled fuel.

15.6.5 Contaminated absorbents should be placed in suitable containers and removed to a safe location for disposal. The selection of tools and equipment to be used in removing spillage and the disposal of contaminated materials should have regard to minimising the risk of ignition.

15.7 Fuel mixture

15.7.1 Mixtures of wide cut and kerosene turbine fuels can result in the air-fuel mixture in the tank being in the combustible range at common ambient temperatures during fuelling and the extra precautions set out in chapter 15.8.2 are advisable to avoid sparking in the tank due to electrostatic discharge. The risk of this type of sparking can be minimised by the use of a static dissipator additive in the fuel being supplied. When this additive is present in the proportions stated in the fuel specification the normal fuelling precautions set out in this publication are considered adequate.

15.7.2 When fuelling with turbine fuels not containing a static dissipator and where wide cut fuels are involved, a substantial reduction in fuelling flow rate is advisable. Wide cut fuel may generate its own static charge when it is being supplied or when it is already present in the aircraft tanks. It is recommended that when wide cut fuel has been used the fuelling overseer should be informed by the aircraft operator and the next two uplifts of fuel treated as though they too were wide cut.

15.7.3 Reduced flow rate has three benefits:

- it allows more time for any static charge built up in the fuelling equipment to dissipate before the fuel enters the tank
- it reduces any charge which may build up due to splashing
- it reduces the extension of the flammable range of the fuel which can occur due to misting in the tank before the fuel inlet point is immersed.

15.7.4 The amount of reduction in flow rate needed is dependent upon the fuelling equipment in use and the type of filtration employed on the aircraft fuelling distribution system. It is difficult, therefore, to quote precise rates of flow. It is, however, recommended that in the circumstances referred to in chapter 15.8.2, the flow rate should be reduced in accordance with the provisions of the Fuel Company's operating manual and not more than a maximum of 1000 litres per minute.

15.7.5 Reduction in flow rate is advisable whether pressure fuelling or over-wing fuelling is employed. With over-wing fuelling, splashing should be avoided by making sure that the delivery nozzle extends as far as practicable into the tank. Caution should be exercised to avoid damaging bag tanks with the nozzle.

15.8 Sources and dissipation of electrical energy that may develop during aircraft fuelling operations

15.8.1 Distinct types of electrical potential difference, with the accompanying hazard of spark discharge, are possible during aircraft fuelling operations. A description of each type together with the practices used to prevent its occurrence is given in the following paragraphs.

Electrostatic charge

15.8.2 This may be accumulated on the surface of the aircraft or fuelling vehicle when conditions are favourable. The hazard of sparking can be eliminated by ensuring that the fuelling vehicle is bonded to the aircraft so that a difference in electrical potential cannot occur between the two. Bonding between the aircraft and vehicle is made by connecting a conductor between designated points on clean and unpainted metal surfaces of both the aircraft and the fuelling vehicle. It is extremely important that the bonding connection between the aircraft and fuel supply vehicle or source is made before any filler caps are removed or fuelling hoses connected. The bonding connections should remain in place until hoses have been disconnected and filler caps replaced.

> **CAUTION: Since it is not possible to be assured of the electrical continuity of a hose that has an in-built bonding lead, hoses should not be considered as conductive for the purposes of dissipating electrostatic charge.**

15.8.3 Where over-wing fuelling is employed, the nozzle of the hose is normally bonded to the aircraft before the filler cap is removed; however, where underwing fuelling is employed, the automatic metal-to-metal contact between the aircraft fitting and the coupling eliminates the need for a separate bonding connection at the nozzle.

15.8.4 Drag chains on fuelling vehicles or conductive tyres on fuelling vehicles and aircraft are often used as additional safeguards but are not considered effective by themselves. However, they are useful since, in the event that the aircraft/vehicle bonding is broken or faulty, the electrostatic charge could be discharged from the aircraft or vehicle through either or both of these items of equipment.

15.8.5 As an additional safety measure, some practices specify individual electrical grounding of aircraft and vehicle. This measure would prevent any possible hazard caused by a broken or faulty bonding. However, this possibility is negligible if proper maintenance and testing of the wire used for bonding purposes between aircraft and fuelling vehicle is carried out.

15.8.6 On completion of fuelling operations, the disconnection of bonding equipment should take place in the reverse order to that described in chapters 15.4.11 (4) (a) and (b).

15.8.7 **Electrostatic Charge - Fuel**. May also build up in the fuel during the fuelling operation. If of sufficient potential, it can cause sparking within the aircraft tank. The charge density in the fuel and the possibility of sparks inside the tanks are not affected by bonding of the aircraft or the fuelling vehicle. However, the use of static dissipator additives in fuel can contribute materially to reducing the risk involved.

15.9 Fuelling systems and equipment

15.9.1 Emergency shut-off mechanisms should be installed as an integral part of hydrant fuelling systems. They should be so located as to be readily accessible from each fuelling stand in the event of an accident or spillage and should not be obstructed by vehicles or equipment.

15.9.2 All fuel dispensing systems should have operating controls which will automatically cut off the supply of fuel on release of the control by the operator or on failure of the operating power source. The operator of the control should have a clear view of fuelling operations.

15.10 Maintenance of ground servicing equipment

15.10.1 All vehicles, their engines and equipment should be subjected to regular inspection and maintenance to preserve their safety characteristics.

Vehicle Engine and Exhaust Systems

15.10.2 It is essential that engines and exhaust systems of fuelling vehicles, other vehicles and equipment (static or mobile) required to operate in the fuelling zone should be subjected to the most stringent and regular maintenance to eliminate defects which may result in the emission of sparks or flames capable of igniting fuel or fuel vapour.

Vehicle Electrical System

15.10.3 The ignition and electrical systems of fuelling vehicles, other vehicles and equipment (static or mobile) liable to operate in or near fuelling zones should be regularly checked and maintained to ensure that they will not be a source of accidental ignition of fuel vapour during-fuelling operations or in the event of a fuel spillage.

15.10.4 It is recommended that all vehicles should be regularly certified by a competent motor engineer to ensure they meet both the appropriate road traffic safety standards and the items outlined in the Appendix A.

Aviation fuel containers

15.10.5 All aviation fuel containers, including vehicles, should be clearly marked with the grade of fuel they contain. All drums of aviation fuel must be labelled in accordance with the Australian industry standard. Containers should not be used for any other product or purpose other than for which they are marked.

15.10.6 No leaking drum or container should be used for fuelling aircraft.

Training

15.10.7 It is necessary that all personnel concerned with fuelling operations, whether employed by aerodrome authorities, fuel companies or aircraft operators, are adequately trained in the duties they are to perform and are supplied with appropriate instructions and guidance on safe operating procedures.

15.10.8 Personnel should be fully trained and practised in the operation of fire protection equipment provided to cover fuelling operations, and the initiation of emergency procedures.

16 Hot Fuelling

16.1.1 Hot fuelling is defined as the fuelling of an aircraft with an engine running. Fuelling an aircraft with its aircraft auxiliary power unit running is not considered hot fuelling if the provisions of paragraph 91.485 (3) (b) of CASR are complied with. These provisions require the aircraft flight manual instructions to permit the practice, and the auxiliary power unit to be operating before hot fuelling commences.

16.1.2 Hot fuelling should not be a routine task due to the elevated risks that are present. It is recommended that it take place only when operationally necessary.

16.1.3 Except for aerial work operations, regulation 91.495 only permits turbine engine aircraft to be hot fuelled. Aerial work aircraft are required to comply with the provisions of regulation 138.300 and should carefully consider fuel volatility when addressing the risks associated with fuelling of different fuel types.

16.1.4 Other than for aerial work operations, the procedures for conducting hot fuelling must be set out in the aircraft flight manual instructions. For aerial work operations the procedures must be set out in the aircraft flight manual instructions or the operator's operations manual. Regardless of the category of flight operations, these procedures must also include the circumstances when the aircraft can be hot refuelled and the procedures to be followed if an emergency occurs during the hot fuelling process. The PIC is responsible for ensuring that these procedures are followed.

16.1.5 All persons involved in a hot fuelling operation should be appropriately trained and briefed on required procedures. Due to the difficulty of providing briefings to ground crew whilst an engine is running, it is recommended that any briefings are conducted in advance and reinforced with written instructions where applicable. For this reason, hot fuelling should only be carried out as a pre-planned activity.

16.1.6 Particular attention should be taken to ensure any ground crew are fully equipped with the appropriate PPE prior to any hot fuelling operation commencing. The safety precautions and equipment mentioned for any fuelling operation elsewhere in this AC should be in place before the arrival of the aircraft at the designated parking place if possible.

16.1.7 It is recommended that at least a 50m buffer zone is set up around the aircraft and fuelling equipment that restricts public access and prevents other aircraft operations in this space.

16.1.8 Except for aerial work operations, regulation 91.500 requires hot fuelling to be only carried out using single-point fuelling equipment or similar where the fuel is not exposed to the air. This means that over-wing or direct into tank fuelling using a hose or nozzle is not permitted. This would exclude using drum stock for hot fuelling.

16.1.9 Aircraft flight manual instructions would not normally include information on the compliance for Part 91. For this reason, it is recommended that operators publish the safety precautions to be followed for hot fuelling in an exposition or similar document.

16.1.10 Approval should be sought from the airport operator if required.

16.1.11 For turbine-engine propeller-driven aircraft the propeller must be no closer than 2.5 m from the fill point and a person using this fill point must have some part of the aircraft structure between them and the propeller to prevent direct access. To comply with this requirement, operators should designate specific parking places with marked distances from fixed equipment such as bowsers or hydrants to enable the pilot to position the aircraft at a suitable location. In the case of mobile equipment that moves to the aircraft, the aircraft parking place could be marked with 2.5 m distances from the propeller arc, and clear signage and procedures designed to prohibit access to this area.

16.1.12 Since the pilot would normally have to remain at the controls of the aircraft while the engine is running, the operator should assign appropriately trained ground crew to operate at least one door on the non-fuelling side and ensure it remains open. If no mechanical devices exist that can secure the door in the open position with the existing airflow, the crew member would have to remain in position during the entire hot fuelling operation.

16.1.13 It is recommended that the person at the controls during the hot fuelling process continuously monitors the process and remains ready to shut the engine down in an emergency. To facilitate rapid evacuation, it is recommended that restraints and harnesses remain unfastened. Doors or windows on the fuelling side should not be opened.

16.1.14 To reduce the possibility of contamination of single-point fuelling connections and the fuelling equipment, it is recommended that hot fuelling only take place on hard, sealed surfaces where blowing dust can be kept to a minimum. The aircraft should be positioned into-wind.

16.1.15 To maintain a line of communication from the person at the controls to the person operating the fuelling equipment to quickly shut it off, operators could use an electronic system that is designed to be used during fuelling. If such a system is not available, sufficient trained personnel should be available to facilitate a pre-arranged visual signal system. These personnel must be able to maintain visual contact between the person at the controls and the person operating the equipment at all times.

Appendix A

Safety requirements for mechanical and electrical equipment in the vicinity of aircraft during fuelling operations

A.1 Applicability

A.1.1 This Appendix applies to all mechanical and electrical equipment operated within 6 metres of an aircraft's fuel tank filling points and vent outlets.

A.1.2 Compliance with these requirements is the responsibility of the ground handling service provider in respect of service vehicles and equipment, and the fuelling operator in respect of fuelling vehicles and equipment.

A.2 Vehicles and plant

A.2.1 All equipment should be of sound design and maintained in safe working condition. All reasonable precautions against fire hazard must be taken. Particular attention must be given to sources of ignition such as:

- incandescent carbon or naked flame which could be emitted from the engine or associated equipment
- arcing between metallic parts of electrical circuits and components caused by:
  - operation of switch contacts
  - faulty cable terminals
  - breakdown of electrical insulation
  - moving contacts or rotary electrical equipment
  - accidental short circuiting or open circuiting
- exposure of hot parts to combustible matter
- overheating of working parts to the ignition temperature of any oils, fuels or other combustible matter in the vicinity of the engines.

A.2.2 Particular attention must be paid to the plant's:

- fuel system
- exhaust system
- electrical system.

A.3 Fuel system

A.3.1 To ensure safety an internal combustion powered fuelling unit must have:

- an air intake system which cannot emit backfire, or one which is fitted with a flame arrester, such as a backfire non-return valve, or a baffled and screened air cleaner
- a securely mounted fuel tank sufficiently clear of the engine to ensure that no leaks or emissions could occur in the vicinity of hot components of the engine, and with its filler positioned so that fuel cannot be inadvertently spilled on the engine, its exhaust, electrical or ignition system during replenishment.

A.3.2 Fuel tank filling openings must be fitted with well-fitting caps. Liquefied petroleum gas systems must comply with Australian Standard 1425 and Australian Standard CB20, and must be fitted with excess flow valves and non-return valves irrespective of tank size.

A.4 Exhaust system

A.4.1 The exhaust system must be provided with means to prevent hazardous emission of incandescent carbon or naked flame. Good condition baffled vehicle mufflers of standard automotive design are acceptable.

Note: Because a higher standard of safety can be more readily achieved with diesel engines than petrol engines, it is recommended that diesel engines be used on all vehicles, pumping plant, etc. intended for operation within 6 metres of an aircraft' during fuelling operations.

A.5 Electrical system

A.5.1 Standard vehicle wiring must be maintained in good condition. All additional equipment such as obstruction lights must have wires and cables well supported, with insulating grommets fitted wherever they pass through metal panels. Equipment must be effectively insulated and mechanically protected to prevent breakdown during use.

A.6 Fuelling vehicles and plant

A.6.1 Aircraft Fuelling vehicles and plant must comply with a relevant Australian Standard in respect to all fire safety standards.

A.7 Electrical equipment

A.7.1 Equipment above ground level. All fixed and portable electrical equipment (other than vehicular) shall be of the same requirements as the Standards Association of Australia (SAA) requirements for equipment operated in Class 1, Division 2 locations except that arc producing devices such as switches, contactors, etc., which are not operated during fuelling operations need not to conform to the requirements for this class of equipment. The controls of all arc producing devices which do not meet the requirements for SAA Class 1, Division 2 locations shall be clearly labelled so that there is no doubt that they are not to be operated during fuelling operations.

A.7.2 Equipment below ground level. Electrical equipment located below the general ground level of the apron (such as apron power outlets, pump control switches, etc.) must comply with the SAA requirements for equipment operated in Class 1, Division 1 locations.

Note: All mobile phones, pagers and radio transmitting devices must be turned off and not operated within 6 metres of filling points, fuel vents or fuelling equipment unless they have been certificated for use in fuelling zones.

A.8 Protection of cable

A.8.1 All cables carrying electrical current at potentials up to 250 volts with respect to earth must have 250 volt grade insulation and should be protected by a plastic sheath resistant to deterioration in the presence of fuel and oil.

A.8.2 All cables situated in areas traversed by vehicles, hand-carts and the like must be fully protected against mechanical damage. The protection must be sufficient to ensure that nothing which tramples the cable can come into direct contact with the sheathing of the cable, or deliver a crushing force directly on to the cable.

A.9 Protective devices

A.9.1 All fuses and overload protective devices must be hermetically sealed and protected by a general purpose enclosure.

A.10 Batteries

A.10.1 All batteries must be suitably covered to prevent accidental shorting of cells and be provided with effective natural ventilation.

A.11 Protection from breakdown in service

A.11.1 All electrical equipment should be suitably insulated and mechanically protected to prevent breakdown whilst in use.

A.11.2 All electrical connections should be secured with spring or lock washers to prevent accidental loosening of connections whilst in use.