CIVIL AVIATION AUTHORITY
OF NEW ZEALAND
Te Mana Rererangi Tūmatanui o Aotearoa

Advisory Circular
AC91-22

Revision 3

1 November 2024

Aircraft Refuelling and Defuelling — Fire Prevention and Safety Guidance Measures

General

Civil Aviation Authority advisory circulars (ACs) contains information about standards, practices, and procedures that the Director has found to be an **acceptable means of compliance** with the associated rules and legislation.

Consideration will be given to other methods of compliance that may be presented to the Director. When new standards, practices, or procedures are found to be acceptable they will be added to the appropriate AC.

Purpose

This AC describes an acceptable means of compliance ~~compalicen~~ with standards for fire prevention and other safety measures carried out by a person involved in ~~respect of~~ aircraft fuelling ~~and safety measures to be observed by a person involved in fuelling (or defuelling) an aircraft~~. It does not override ~~those~~ procedures developed by recognised and certificated fuel company suppliers.

Related Rules

This AC relates to civil aviation rules 91.15, 121.91, 125.73, 135.73 and Part 139. It would also be of interest to adventure aviation aeroplane and helicopter operators, agricultural aircraft operators, and aerodrome operators.

Change Notice

Revision 3 is not a substantive update to this AC. It fixes typos, standardises spelling and makes other stylistic changes to align with current AC format. It also updates some references and deletes a reference to the Hazardous Substances (Classes 1 to 5 Controls) Regulations, 2001, which have been revoked.

~~Revision 2 restructures and expands this AC to provide greater guidance for industry on the requirements for and implications associated with remote fuelling operations. TAIC report AO-2016-008 found and outlined various gaps in NZCAA advisory material, and subsequent industry practice regarding control of fuel contamination during field operations. This revision addresses those findings.~~

~~Cancellation~~

~~This AC cancels AC91-22 Revision 1 dated 7 December 2018.~~

Published by
Civil Aviation Authority
PO Box 3555
Wellington 6140

Authorised by
DCE Aviation Safety

Version History

This revision history log contains a record of revision(s) made to this AC.

Revision No.	Effective Date	Summary of Changes
AC91-22, Rev 0	14 October 2015	~~This is the~~ Initial issue. ~~of this AC~~.
AC91-22, Rev 1	7 December 2018	~~Title of the~~ AC title ~~is~~ amended. Version history log ~~is~~ inserted. Numbering system ~~is~~ revised. Inserted new definitions for *Class 3.1A—Flammable liquid* and *Class 3.1C—Flammable liquid* Some paragraphs updated or added. Notes added or amended. Formatting changes made. ~~Paragraphs 1.2, 1.3(c), 1.5(d), 1.5(g), 4.1.1, 4.1.2, 4.1.14, 4.2.4, 4.2.5, 4.2.7(a), 4.3.1, 4.3.2, 4.4.2(c), 4.5.1, 4.5.2, 4.5.7, 4.7.1, 4.7.2, 4.7.3(a), 4.7.3(b), 4.7.3(c), 4.7.4, 5.1.1, 5.2.2, 5.3.2, 6.6.4(b), 6.6.4(c), 6.6.7, 6.6.9, 7.1.1, 7.1.3(e), 7.1.3 (f), 7.1.3(g), 8.3.1, 8.4.2 (c), 8.5.3, 8.7.5 are amended.~~ ~~New paragraphs 1.5(h), 4.7.6, 4.8, 5.4.4(f), 6.3.1(d)(8), 6.4.1(e), 6.6.2,6.6.3, 6.6.8, 6.8.1(h), 7.1.3(a)(3), 8.6.1(f), 9 are inserted~~ ~~New explanatory notes are inserted under paragraphs 4.2.6, 4.5.5, 4.6.2, 7.1.3(g)~~ ~~Headings 6.8 and 8.6 are amended~~ ~~End note 5 is amended~~ Appendixes 1 and 2 revoked and replaced.
AC91-22, Rev 2	25 September 2019	Added more guidance on remote fuelling operations to address the findings of TAIC report AO-2016-008. ~~Revision 2 restructures and expands this AC to provide greater guidance for industry on the requirements for and implications associated with remote fuelling operations to address the findings of TAIC report AO-2016-008.~~ Inserted new definitions for *Bonding* and

		Grounding New paragraphs added and updated. Some formatting changes. ~~Paragraph 4.7 and 4.9 are inserted. Previous 4.7 becomes 4.8 and previous 4.8 becomes 4.10~~ ~~Paragraphs 6.6 and 6.7 removed and inserted in 4.9.~~ ~~Paragraph 6.8 amended to 6.6~~ ~~Paragraph 6.7 reinserted with new material~~ ~~Headings 4.8, 4.9 and 9 are subsequently amended.~~ ~~Headings 4.7, 6.7 and 9.4 are subsequently inserted~~ ~~Paragraphs 4.1.17, 4.2.1, 4.2.7, 4.4.2, 4.5.7, 4.7.1, 4.8.3, 4.8.5, 4.8.8, 4.9.4, 5.2 note 1, 6.7.7, 7.1.3 are subsequently amended~~ ~~New paragraphs: 4.1.18, 4.1.19, 4.5.9, 4.5.10, 4.7.5, 4.7.6, 4.8.2, 4.8.4, 4.9.1, 4.9.2, 4.9.3, 4.9.6, 4.10.3, 4.10.4, 4.10.5, 6.7.1, 6.7.2, 6.7.3, 6.7.4, 6.7.5, 9.4 are subsequently inserted~~
AC91-22, Rev 3	1 November 2024	Fixes typos, standardises spelling and makes other stylistic changes to align with current AC format. Updates references. Deletes reference to Health and Safety at Work (Hazardous Substances) Regulations, 2001, which have been revoked.

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1. Introduction

1.1 Any person engaged in the fuelling of aircraft is advised to take account of the guidance material set out in this AC.

1.2 An airport authority or aerodrome operator is responsible for providing a safe environment for the fuelling of aircraft at its airport.

1.3 This AC incorporates many of the provisions of:

(a) Civil Aviation Safety Order (CASO) No. 5, repealed in April 1997 (which prescribed rules for fuelling of aircraft).

(b) *JIG 1 Standard Aviation Fuel Quality Controls and Operating Standards for Into-Plane Fuelling Services*[1].

(c) *JIG 4 Aviation Fuel Quality Control & Operating Standards for Smaller Airports*[2] (endorsed by IATA technical fuels group and recommended as an additional reference).

1.4 The fuel supply companies also have jointly agreed guidelines for fuel handling procedures to be used for into-plane fuelling services and many of the provisions of these guidelines have been included into this AC.

1.5 Other sources for this AC include the:

(a) FAA AC 150/5230-4B *Aircraft Fuel Storage, Handling, Training Dispensing on Airports*

~~(b) Operating Standards for Joint Into-Plane Fuelling Services~~

(b) CASA ~~AC~~ AC 21-99(1), *Aircraft Wiring and Bonding*

(c) Fuel quality control regulations of the fuel supply companies

(d) JIG *2 Aviation Fuel Quality Control & Operating standards for Airport Depots & Hydrants*

(e) CAA ~~Civil Aviation Authority~~ of New Zealand ~~(CAA)~~ publications (GAP and Vector)

(f) Aircraft flight manuals

(g) EI/JIG Standard 1530 *Quality assurance requirements for the manufacture, storage and distribution of aviation fuels to airports* (information on fuel supply channels to airports)

(h) Hazardous Substances and New Organisms Act 1996 ~~Hazardous Substances (Classes 1 to 5 Controls) 2001~~

(i) Health and Safety at Work (Hazardous Substances) Regulations 2017

(j) AS/NZS 60079.10.1:2022 ~~09~~ Explosive atmospheres - Classification of Areas - Explosive gas atmospheres

[1] https://www.jig.org/standards-publications/jig-1-standard/

[2] https://www.jig.org/standards-publications/jig-4-standard-2/

(k) Australian Civil Aviation Order 20.9, Para 4.4 only

2. Applicability

2.1 This AC provides advisory material/guidelines or information regarding safe practices/procedures, in respect of aircraft fuelling as per Parts 91, 121, 125, 135 and 139 requirements for aircraft fuelling and ground fire precautions. Applicable regulations made under the Hazardous Substances and New Organisms Act 1996 also apply (refer to rule 91.15).

2.2 Coverage of the different aspects of aircraft fuelling and ground fire precautions is not exhaustive in this AC. This AC sets out the main elements.

3. Definitions

~~3.1 Civil Aviation Rule Part 1~~

These terms are aviation-specific definitions in Part 1, *Definitions and Abbreviations*:

~~**Certified handler** is someone who has been certified to handle very hazardous substances as defined by Worksafe New Zealand [3].~~

Class 3.1A—Flammable liquid means a liquid that has a flash point of below 23ºC and has an initial boiling point (IBP) of a maximum 35ºC and includes petrol-based products.

Class 3.1C—Flammable liquid means a liquid that has a flash point at or above 23ºC, but at or below 60ºC, and includes kerosene-based products.

These terms below are in addition to the aviation-specific definitions in Part 1.

~~2.1 For the purpose of this AC~~

Bonding means the electrical connecting of two or more conducting objects not otherwise adequately connected.[4]

Certified handler is someone who has been certified to handle very hazardous substances as defined by Worksafe New Zealand [5].

Grounding means the electrical connecting of conducting object to primary structure. The main frame, fuselage, and wing structure of the aircraft (commonly referred to as ground) or earth electrode, for return of current.

Fuelling includes refuelling and defuelling aircraft, and the draining of aircraft fuel tanks [6].

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[3] See https://worksafe.govt.nz/topic-and-industry/hazardous-substances/certification-authorisation-approvals-and-licensing/certification-of-people/certified-handlers/

[4] As defined in CASA AC 21-99(1).

[5] See https://worksafe.govt.nz/topic-and-industry/hazardous-substances/certification-authorisation-approvals-and-licensing/certification-of-people/certified-handlers/

[6] Aircraft fuel tank calibration, aircraft fuel flow tests, and the draining of aircraft fuel tanks which are normally conducted within hangars at engineering bases, are not deemed to be fuelling. Special procedures

Fuel has the same classification as those classified by the Hazardous Substances and New Organisms Act 1996 as listed at http://www.legislation.govt.nz/.

Fuelling safety zone/area means any area within a radius of at least 3 metres (10 feet), or as specified by local regulations, from filling and venting points on the aircraft, hydrant pits, fuelling vehicle and its hoses in use.

Overseer means a person appointed by an operator to ensure that the fuelling procedures are complied with.

~~***NOTE**: See also Civil Aviation Rules Part 1 for other terms.*~~

4. General

4.1 General precautions

4.1.1 Personnel engaged in the fuelling of aircraft must not carry matches, cigarette lighters, two-way radios, or any other item which may cause a fire during the fuelling or defuelling of an aircraft. Mobile phones are not to be used in the vicinity of an aircraft while ~~whilest~~ it is being refuelled or defueled.

4.1.2 Do not carry out fuelling during an electrical storm or other hazardous conditions such as excess wind, fog, during aircraft de-icing procedures, etc. Each location should develop extreme weather or other extreme event guidelines on realistic scenarios relative to each location.

4.1.3 Do not operate a cell phone, radiotelephone device, pager device, portable electronic device (PEDs), electronic flash equipment, or photographic flash bulb within 8 metres of the fuelling tanker or 3 metres from aircraft fuel points and vents unless certified intrinsically safe or flameproof.

4.1.4 Maintain a clear path from the aircraft for quick removal of aircraft fuelling equipment in an emergency. This may not apply to aircraft fuelling dispensers if agreed by the fuelling agency, aircraft operator and airport authority.

4.1.5 Fuelling equipment access to and exit from fuelling operations should also be kept free of power units and associated cabling.

4.1.6 Vehicles and equipment should be kept clear of aircraft passenger exits to allow for quick evacuation of passengers and crew members in an emergency.

4.1.7 Trolleys, handcarts or any vehicle used within 15 metres of the aircraft, or the fuelling equipment should be fitted with non-metal tyres/wheels.

4.1.8 In-ground power units located within 5 metres of an aircraft vent should have electrical compliance certificates, or meet the requirements of a class one, zone one installation, or both.

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determined by the aircraft operator, the airport authority, the fuel company, and the maintenance organisation and should be used for the protection of these operations.

4.1.9 Electrical hand lamps or flashlights used directly in the fuelling operation should be flame proof and safe for use.

4.1.10 Hoses should be run out on selected routes which will prevent them from being run over by aircraft-servicing vehicles. Kinking and twisting of hoses should be avoided. Pressure fuelling couplings and overwing nozzles should not be dragged over the ground. Dust caps should be fitted if required or the coupling stowed so as to reduce the risk of damage or the entry of dirt and water into the nozzle. Fuelling hoses and bonding wires should not be allowed to come into contact with a fixed ground power unit or in-ground power unit (IGPU) or associated electrical cables and should be kept as far away from them as practicable.

4.1.11 Before fuelling, the fuelling vehicle system should be checked for leaks, the filter differential pressure should be observed as normal, and any pressure control equipment should be checked for correct action by observing the reading of the appropriate pressure gauges on the vehicle.

4.1.12 Clear lines of communication should be established between the operator delivering the fuel, and any other person(s) directly associated with the fuelling operation. For example: pilot/maintenance personnel monitoring cockpit fuel contents gauges.

4.1.13 When delivering fuel, the operator should be positioned at a point where a clear view of the vehicle control panels and aircraft fuelling points is available. Deadman control should always be used for pressure refuelling and should never be wedged open.

4.1.14 During fuelling, do not perform any aircraft maintenance which may cause a fire with fuel vapours or movement of control surfaces that may cause injury to refuelling personnel or equipment.

4.1.15 Fuel spills are fire hazards and cause environmental damage. Aircraft engines when hot can be a fire ignition source. Therefore, take extra care not to spill fuel when an aircraft engine is hot, particularly when fuelling equipment is close to the aircraft.

4.1.16 If fuel spills, fuelling should stop and the spillage covered immediately with materials such as sand, sawdust, dry earth, or an agent such as foam or dry chemical extinguisher powder, to reduce the fire hazard. The aircraft should be moved clear of the contaminated area before any engine is started. Local airport regulations may also be applicable.

4.1.17 Prior to fuelling, personnel should ensure that all equipment used in the fuelling operation is clean and free from contamination.

4.1.18 Fuel filler caps should not be opened until the area surrounding the filler cap is completely clean. Filler cap configurations where the cavity opening is flush with the exterior skin are particularly vulnerable to contamination and strict cleanliness standards should be adhered to at all times.

4.1.19 Fuel that is not adequately labelled, is from an unknown source or is stored in containers or tanks that show visible signs of deterioration should not be used.

4.2 Bonding/grounding

4.2.1 The published procedures on bonding contained within this AC should be strictly followed. The aircraft and fuelling equipment should be electrically bonded together

throughout the fuelling operation to ensure that no difference in electrical potential exists between the units.

4.2.2 Bonding requirements and electrical continuity checks should be in accordance with AS/NZS 60079.14 ~~Explosive Atmospheres Pt 14 Design Selections Erection and Initial Specification~~. CASA's ~~AC~~ AC21-99 provides further guidance also.

4.2.3 Bonding leads should be examined for security of connections and damage prior to use. Clips should be intact and undamaged.

4.2.4 Bonding between the fuelling vehicle and the designated bonding point of the aircraft should be completed before any hoses are connected or tank filler caps opened. Bonding should be maintained until all hoses have been finally disconnected or tank filler caps replaced.

4.2.5 When grounding aircraft, the fuelling equipment and aircraft should be grounded by means of a "Y" grounding cable and not through the fuelling vehicle. Hydrant pits or hydrant pit internals should not be used as bonding connections. Where bonding is carried out, it should be completed before connecting hoses or opening filler caps.

4.2.6 When overwing fuelling, make sure to follow the correct procedure for inserting the nozzle into the tank filler. If the filler caps have been previously removed to dip the tank contents, the caps should be replaced, and any vapour allowed to disperse before starting any fuelling operation.

Note: *In some installations a dipstick can be used to confirm fuel quantity in the aircraft's tank – see Appendix 2.*

4.2.7 The fuelling procedure may vary with aircraft type, but the following additional steps are recommended:

(a) equalise the electrical potential by touching the nozzle to the metal filler cap surface or adjacent bonding tab (where fitted), taking care to protect the wing from damage

(b) open the fill point cover flap (where applicable)

(c) attach the nozzle bonding jack or clip, where fitted, to the bonding point or cover flap, with the filler cap still closed

(d) ensure the area around the filler cap is clean and dry

(e) open the filler cap

(f) insert the fuelling nozzle - avoid damaging the aperture, or 'bottoming' the nozzle which could possibly damage the internal structure and/or protective coatings

(g) start fuelling.

4.3 Fuelling personnel

4.3.1 Personnel engaged in the fuelling of aircraft should be dressed in protective clothing that does not cause static electricity build-up to prevent a flashback. The European standard EN 1149-5 is an acceptable reference for assessment ~~assessement~~ of clothing suitability, if needed.

4.3.2 Personnel should wear non-slip semi-conductive footwear, safety glasses and fuel resistant gloves.

4.3.3 Personnel should be instructed in the procedure for alerting local fire services in an emergency.

4.4 Fuelling personnel training requirements

4.4.1 Fuelling operations should be carried out by competent personnel, thoroughly trained in aircraft fuelling procedures, the operation of fuelling equipment, the action to be taken if an emergency occurs, and safety procedures for storing, handling, and dispensing fuel, lubricants, and oxygen.

4.4.2 Training of personnel should also include:

(a) identifying, explaining the major characteristics of, and distinguishing between, the various types of fuel (using flammability and colour)

(b) the use of fire extinguishers

(c) bonding requirements and methods

(d) contamination awareness training, including:

(1) fuel contamination types

(2) testing processes and protocols

(3) management of fuelling cycles

(e) knowing the location of and operation of the following:

(1) emergency stop controls

(2) switches on fuelling equipment and on the apron, as applicable, for controlling the flow of any flammable products

(3) closing valves in the piping system which may release product to the fire area

Note: *Operational knowledge of system components such as self-closing valves, internal valves, and vents will reduce uncertainty and avoid delay and error.*

(f) the aircraft refuelling or defuelling panel, switches and associated procedures in accordance with the agreed IATA fuel service level guideline and associated indemnity

(g) methods for alerting every person associated with the fuelling operation

(h) summoning the nearest available fire services

(i) safety measures set out in section ~~part~~ 9 of this AC.

4.5 Driving and positioning of vehicles

4.5.1 Vehicles driven in airside operations should comply with local aerodrome procedures in condition and operation, and should, especially, in fuelling/defuelling operations, be driven with care.

4.5.2 When driving a vehicle, always move forward into the fuelling position and exit in a forward direction, without reversing, if practicable. If the vehicle has to be reversed into

position, a guide should be stationed at the rear of the unit to direct the manoeuvre. It is recommended that the driver of the refuelling vehicle walk around the vehicle completely before departing the aircraft. This gives opportunity to ensure that everything is completely stowed, and that nothing external has changed, such as aircraft flaps being lowered. Also, loose fuel caps, fuel doors, errant dipsticks should be checked for, prior to driving away from the aircraft already refuelled/defueled.

4.5.3 Truck and trailer combinations should not be reversed into position. Once the vehicle is in position, the driver should not leave the cab until the parking brakes have been applied and locked in position.

4.5.4 The vehicle should be positioned at a safe and convenient distance from the fuelling points on the aircraft to permit:

(a) minimum hose length

(b) maximum visual and manual control

(c) speedy connection and disconnection of fuelling hoses

(d) avoidance of aircraft fuel tank vent(s) safety zones (3m radius), APU exhaust efflux or other danger areas.

4.5.5 Special precautions should be taken to ensure that vehicles used for underwing fuelling have a sufficiently low profile for this purpose. Vehicles should be positioned so as to avoid the aircraft wing, winglets or other surfaces bearing down onto the vehicle as the aircraft settles under increased fuel load. The position of aircraft flap tracks in case of unheralded flaps extension should be taken into account.

Note: *Slats and flaps may be extended as part of an aircraft overheat protection system on some aircraft such as the Airbus A320 family of aircraft.*

4.5.6 Aircraft servicing vehicles must not be driven at excessive speed around fuelling operations and care must be taken to avoid contact with the fuelling vehicle, hoses and couplings, bonding wires, and any associated appliances. The operator or the overseer should ensure that such vehicles should not be driven at excessive speeds and airside driving rules and speed limits imposed by the aerodrome should be adhered to. If no regulations exist, a limit of 25km/h should be enforced on apron roads and less than 10 km/hr when in proximity to aircraft.

4.5.7 Any person engaged in fuelling operations must ensure that all hoses and fuelling equipment are disconnected from the aircraft and stowed safely, prior to aircraft departure. Operators certificated under various rule parts should include their method for ensuring this happens in their fuel management processes.

4.5.8 The fuelling vehicle - either a hydrant dispenser or a tanker/fueller - should be positioned so that it can be driven away quickly in an emergency. For this reason, it is imperative that other ramp users do not obstruct the exit route of a fuelling vehicle.

4.5.9 During fuelling at remote locations, care should be taken to ensure that vehicles and trailers are positioned well clear of rotating blades and in clear vision of the pilot.

4.5.10 Regardless of vehicle positioning, no member of the fuelling team may stand on either the vehicle or fuelling equipment during fuelling operations, unless the vehicle concerned has been specifically designed or modified to be so used.

4.6 Fuelling or defuelling in hangars

4.6.1 Fuelling/defuelling is generally not permitted in hangars or similar enclosed buildings, except by special agreement with the respective operators and the appropriate airport authorities, and in accordance with relevant and approved special procedures which should include satisfactory liability or indemnification protection.

4.6.2 Fuelling vehicles involved in such operations should remain outside the hangar.

Note: *See section ~~part~~ 7 of this AC for defuelling.*

4.7 Fuel storage equipment standards

4.7.1 Use only jerry cans specifically manufactured as fuel containers. The traditional metal jerry cans are preferable to the plastic versions available on the market. Plastic jerry cans intended for use with fuels will have been manufactured to a recognised standard. In New Zealand, for cans up to 25L in size, this is ~~Australian/New Zealand standard~~ AS/NZS 2906:2001*, Fuel Containers*, and this identification is embossed permanently on the side of the container. Each jerry can manufactured ~~manufacturered~~ to this standard will have a date of manufacture also printed on the can. Cans manufactured in excess of five years prior to ~~to~~ date of fuelling should not be used and the fuel discarded.

4.7.2 Do not use plastic containers not designed for fuel, as their deficiencies may pose hazards such as:

(a) a tendency to accumulate a static charge (refer to section ~~paragraph~~ 5.2)

(b) fuel could degrade the container material

(c) inadequate structural strength and impact resistance

(d) lack of a proper fuel grade label and other required markings

(e) insufficient resistance to ultraviolet radiation and heat

(f) cap gaskets inadequately retained.

4.7.3 In particular, the cap gaskets have been identified as an actual hazard. The standard requires that these be physically restrained in the cap by a retaining ring, or other means of preventing accidental loss. Obviously, the gasket itself should also be fuel resistant.

4.7.4 Apart from simply falling out of the cap and preventing proper sealing, two ways in which the gasket can be hazardous.

(a) Embrittlement and subsequent disintegration. The fragments can then be tipped into the aircraft fuel tank along with the fuel, and, over time, can either clog the tank outlet or the fuel system filter(s).

(b) Progressive degradation /disintegration by turning to ‘mush’ (possibly more likely in jet fuel), also resulting in filter clogging.

4.7.5 All mobile tanks used to store and transfer fuel by road must have been designed and built in accordance with the relevant provisions of a standard commensurate with: Health and Safety at Work (Hazardous Substances) Regulations 2017, Part 16.

4.7.6 Storage of fuel in drums falls under the same graded set of requirements as for larger, above ground storage facilities. Worksafe New Zealand has published advisory material

called *Good Practice Guidelines: Above Ground Fuel Storage on Farms*. That document should be referenced when installing, inspecting and using storage facilities of those types. Specific requirements for the use of drums to store fuel are identified in section 6 of that document.

4.8 Fuel contamination and testing

4.8.1 Contaminants (especially water or incorrect fuel grade) in the fuel have been known to cause engine failures – usually just after the aircraft has become airborne. Fuel contamination could also be in the form of solid contaminants such as sand, corrosion products, or other debris. Water contamination in fuel continues to be a major source of fuel related incidents.

4.8.2 Below are common examples of ways that contaminants can enter fuel:

(a) Leaks in portable, under or above ground tanks

(b) Open filler ports

(c) Fuelling equipment contamination

(d) Storage vessel degradation

(e) Poorly controlled high pressure water cleaning methods causing forced water entry.

(f) Condensation

(g) Incorrect identification of fuel type

4.8.3 Some fuelling practices are likely causes of contamination, particularly when undertaking remote fuelling operations, such as when fuelling helicopters while ~~whilst~~ the main rotor is turning, or when transit of fuelling equipment along dirt roads has allowed contaminants to build up on fuelling equipment. Under these conditions, particles of foreign material (dust and grass) are likely to be introduced into the fuel system through the tank filler.

4.8.4 The specific types of fuel contamination are many and varied, however can be grouped into the following broad categories:

(a) water

(b) solid particles floating in the fuel

(c) particulate matter held in suspension in the fuel

In particular, particles held in suspension pose a serious threat to flight safety as they may be so fine that they are not captured by filtration elements in the fuelling equipment. Fine particles then enter tanks and may cause contamination of fuel nozzles or injectors as the fuel is atomised and burnt. Dissolved water may also be present in fuel without being visibly obvious and while ~~whilst~~ dissolved, it is not a hazard to aircraft operation. However, temperature changes may cause the water to separate out of the fuel and become free water, which can cause catastrophic risk to aircraft safety. Entrained water is similarly difficult to identify as it consists of tiny droplets that have been agitated into fuel by pumps etc. This water will separate into droplets with settling time, which may mean that water is only obviously identifiable long after the fuel transfer operation took place. General settling times to be applied are 1 hour per vertical foot of tank space for Jet fuel and 15 mins per vertical foot of tank space for AVGAS.

Note: *Go/No go filters that snap shut when water is sensed in the fuel are not to be considered fail safe. Many instances have been reported that indicate water has been allowed to pass through these types of filters without being detected.*

4.8.5 To minimise the risks of this happening, a fuel sample should always be taken from the refueller and tested for solid particle contamination, undissolved water and appearance of fuel. This test should be carried out at any time fuel is transferred between any of the storage vessels identified in paragraph 6.7.2 of this AC and at scheduled times for stored fuel. In addition, fuel drain checks from the aircraft should be carried out by the aircraft operator before the first flight of the day – and after refuelling. In general, any form of contaminated fuel should not be used and reference should be made to the aircraft type-specific documentation, such as maintenance manuals, task cards or the aircraft flight manual. Additionally, fuel that is not adequately labelled, is from an unknown source or is stored in containers or tanks that show visible signs of deterioration should not be used.

4.8.6 Water finding paste can be used for identifying free water for either Jet A1 and Avgas. A water detector capsule can be used to identify suspended water in Jet A1, a fresh capsule must be used for each check. In cases where fuel contamination persists frequently then the source of the contamination needs to be investigated.

4.8.7 Nozzle size of the refuelling equipment versus the aircraft tank aperture size, is not a guarantee against misfuelling. It is of the utmost importance that the appropriate markings or decals are maintained and regularly checked for presence, to show the type of fuel, grade and capacity of the tank, visible to the refueller.

4.8.8 The following general considerations apply to taking a fuel drain sample when required.

(a) After transferring fuel, allow the fuel to settle for as long as possible. This gives any impurities a chance to settle into the drain sump of each tank.

(b) At an intermediate aircraft stop, it is recommended to fuel the aircraft first, before attending to other business. This will normally allow enough time for any free water to settle out.

(c) Ensure that the drain vessel is clean before taking the sample. Hold the sample to the light and inspect it visually for sediment and water (normally indicated by small globules sitting on the bottom, or by a ‘cloudy’ appearance). Check the fuel is the correct colour for the intended grade of fuel. Avgas is coloured blue and Jet A1 can be a straw colour or colourless (smelling is a health hazard and is no longer considered as an advisable test/verification method. The only way of detecting suspended water in Jet A1 is by water detector capsules, and/or free water in either Jet A1 and Avgas is by water finding paste). Water detector capsules can be supplied with a syringe as a kit. Know how many drain points the aircraft or storage vessel has. Some aircraft or storage facilities have belly or cross-feed selector drain points. Know where these are and drain them daily. Others have long fuel lines meaning that contaminants may take some time to reach the drain point.

4.8.9 Always confirm that each spring-loaded drain valve (if such a type is fitted) shuts securely afterwards, as any leaks will result in higher than normal in-flight fuel consumption and possible external venting of fuel vapour. Take care with remotely-operated fuel drains, and make sure that they also close properly after operation.

4.8.10 If the sample tests positive for water or other contaminants, empty the sample vessel and continue draining until a clean sample is obtained. Be sure to empty the sample into

a fuel disposal container as fuel can also degrade bitumen surfaces. Never tip the sample back into the aircraft tank, even if it appears clean.

4.8.11 Tipping samples of drained fuel into ground support equipment is not recommended.

4.9 Fuel storage and equipment maintenance

Note: *If any person or organisation that is storing fuel for the purposes of resale or reuse by another person or organisation, then the provisions of ~~Civil Aviation Rule~~ Part 19, Subpart F must be complied with.*

4.9.1 The risks of contamination noted in section ~~paragraph~~ 4.8 of this AC, raise various instances where contamination of stored fuel can occur. For that reason, it is important that the following precautions are noted and complied with when storing fuel.

4.9.2 Operators of aircraft must nominate who is to be responsible for the inspection and maintenance of aircraft fuel storage and transfer equipment and for the routine testing of stored fuel. These responsibilities should include:

(a) Checking fuel received is of the required specification, free from water or other contamination and correctly stored.

(b) Determining frequency of scheduled testing and checking of all fuel storage tanks and refuelling units

(c) Training of each person designated to conduct this work

(d) Maintaining the records identified in section ~~paragraph~~ 4.10~~1~~ of this AC.

4.9.3 While ~~Whilst~~ each operator is responsible for determining their own inspection schedules for fuelling equipment that identify when checks are be conducted and by who, the following general areas should be covered:

(a) Procedural checks for contamination; both scheduled and prior to use

(b) Condition of storage tanks, drums, bladders and Jerry Cans

(c) Inspection of hoses, couplings and nozzles for leaks, damage and contamination

(d) Inspection and renewal of filters

(e) Examine bonding equipment for security of connections and damage

(f) Seals for leakage and degradation

(g) Fuel identification and caution decals for legibility.

4.9.4 Fuels such as Avgas and two stroke mixes will store for up to one year in a sealed container. After that period the fuel may still be fit for purpose but problems such as hard starting and spark plug fouling may occur due to lack of light components. Once the seal is broken then lighter components evaporate and the storage life is best assumed to be 6 months at ambient temperatures of 20º C and 3 months at ambient temperatures of 30º C or more. Aviation turbine fuel should not be stored for longer than 12 months. After these periods, aging tests should be carried out.

4.9.5 Reference to (Energy Institute) EI 1550 (Handbook on equipment used for the maintenance and delivery of clean aviation fuel), as at latest revision can be made for more information on filtration.

4.9.6 When storing drums of fuel, drums should be oriented on their side with bungs located at 3 and 9 o'clock ~~o'cloock~~ positions and the bung end of the drum at a lower level than the other end. This is to decrease the risk of breathing between the fuel inside the drum and the atmosphere outside.

4.10 Records

4.10.1 To comply with fuel specification traceability and quality control requirements, all checks and tests on aviation fuel and fuelling equipment should be recorded.

4.10.2 Effective records should detail what was first observed (e.g. volume of contaminant, colour, type, location), what actions were taken to rectify the situation and what the final result was. Detailed records are valuable.

4.10.3 Records should also include a list of all fuel storage and transfer installations and vessels in the organisation's possession and the current condition of each. Inspections of equipment must also be recorded.

4.10.4 Scheduled and incidental fuel drain testing must be recorded.

4.10.5 Records must be kept of any training conducted with staff on fuelling or inspection activities. FAA AC 150/5230-4C ~~B~~ *Aircraft Fuel Storage, Handling, and Dispensing on Airports,* provides guidelines as to the possible content of a fuel safety training programme.

5. Fire Hazards

5.1 Fire or explosion risk

5.1.1 During fuelling operations, air and fuel vapour are displaced from the aircraft fuel tanks. This potentially explosive mixture is expelled via tank vents and the fill point(fuel vapour is heavier than air. The fuel vapour can accumulate in low points, and may "flow" downhill for quite some distance) . This combined air (oxygen) and fuel vapour forms an explosive mixture quite capable of causing fatalities or destroying an aircraft or hangar.

5.1.2 An explosive fuel-air mixture can also be formed by splashing a volatile fuel in an open container, as in washing oily components, or by pouring fuel from a sample container into another open container. All it takes to initiate a fuel explosion is just a small spark or a hot surface - not necessarily in the immediate vicinity, given the ability of fuel vapour to flow long distances. If a fire breaks out, extinguish using dry powder, foam or carbon dioxide extinguishers, or a water fog. Do not use a water jet, as this will spread the burning liquid and may make matters worse. Fires in confined spaces should be dealt with by trained personnel wearing appropriate breathing apparatus. Ensure an escape path is always available from a potential fire.

5.2 Static electricity

5.2.1 Commonly referred to as 'static', this is one of the most hazardous sources of ignition. Fuel is an extremely flammable liquid and explosive fuel/vapour mixtures may form at ambient temperatures. The presence of an ignition source can spell disaster. So static

and aviation fuel is a bad mix. The risk is always present, and must be managed, even in seemingly innocuous situations. The considerations apply equally to gasoline fuels and Jet A-1.

5.2.2 Static can be generated from a number of sources, typically by the flow of fuel from the fuelling equipment to the aircraft, and by the wearing of synthetic clothing (high-visibility vests can be a hazard in this case – see 4.3 above regarding clothing). A resultant electrical charge can build up on an aircraft, the fuelling equipment, or a human body, and when two unequally charged objects are brought close enough together, the charge will equalise by means of a spark. Static sparks can be of the order of thousands of volts and combined with the presence of fuel vapour of sufficient concentration will result in a potentially catastrophic explosion. This can be avoided by the use of the proper bonding leads or cables, coupled with procedures to equalise any electrical potential, before any hazardous vapour is introduced into the surrounding areas.

Note: *The grounding of helicopter skids does not necessarily equalise the electrical potential between fuelling equipment and the helicopter – bonding the helicopter is an acceptable means to achieve a safe state for fuelling. Helicopters with wheeled landing gear and those parked on trolleys are particularly susceptible ~~suceptable~~ to electrical potential to be present.*

Note: *Further information on bonding may be found in FAA AC 25.899-1,* Electrical bonding and protection against static electricity. ~~*"Electrical bonding and protection against static electricity".*~~

5.3 Preventing static hazards

5.3.1 The most important thing to do before fuelling is to correctly bond the pump or fuelling equipment to the aircraft. When fuelling from drums, always ensure that there is a bonding lead connected to both the aircraft and the drum in use and make the necessary connections before removing any fuel caps. Additionally, it is good practice to keep the fuelling nozzle in physical contact with the filler aperture at any time fuel is being pumped. This also applies to the filling of portable containers – place the container on the ground and maintain contact between the fuel nozzle and the container. Containers complying with Australian/ New Zealand standard 2906:2001 have this instruction on the label. Also check the bonding to the aircraft of any stands or ladders used to gain access to any overwing fuelling point.

Note: *Should the bonding cable be accidently disconnected during the fuelling process, stop fuelling immediately and wait for any static to dissipate before reattaching the bonding cable.*

5.3.2 Despite the traditionally accepted practice of filtering fuel through chamois leather, this is now not recommended. Studies have found that the use of a chamois can be a static hazard in itself, synthetic chamois even more so. Any drum pump should be more preferably fitted with an appropriate in-line filter, and the delivery hose must be fuel-specific. The fuel supplier should be able to advise on the correct equipment, and it is very important that the correct equipment is used, inspected and maintained in accordance with manufacturer's recommendations.

5.4 Spillage of fuel

5.4.1 Spillage and leakage of fuel should be avoided at all times. Every spill is a fire hazard as well as an environmental pollutant and should be dealt with immediately. Each spill presents a different situation involving many variables, such as size of spill, weather conditions and location of spill.

5.4.2 Action required will depend on each particular situation, so no one set of instructions will apply in every case. Prompt action, good judgement and initiative by well-trained personnel are important to prevent hazards arising from fuel spills.

5.4.3 The overseer is responsible for ensuring that the local and national regulations relating to environmental pollution are fully met. This includes keeping an up-to-date spillage emergency plan and ensuring that all staff are aware of the plan and what must be done if fuel spills.

5.4.4 The following general procedures should be adopted into the plan for any spillage:

(a) fuelling should be stopped immediately

(b) eliminate all sources of ignition in the vicinity of the spill (or released vapour)

(c) notify the appropriate local fire services without delay

(d) evacuate unauthorised persons and vehicles to a safe area and prevent further movement until the hazard is removed

(e) restrict the running of engines and reduce any risk of ignition

(f) the aerodrome operator should be notified.

5.4.5 Smaller spills should be immediately soaked up using non-combustible absorbent material, such as sand or dry earth while someone stands by with a dry powder or foam extinguisher in case a fire breaks out. This also applies to places where fire services are not stationed. Be sure to dispose of the contaminated material in a safe place afterwards and any tools used for this purpose must be non-flammable.

CAUTION: If any fuel spills onto your body or clothing, do not remove your clothing except under shower. If you take off your clothing without first dousing under water, you could create a static spark and set yourself on fire.

5.4.6 In any case, take great care to prevent the spillage, as far as possible, from entering into the drainage system.

5.5 Fire extinguishers

5.5.1 Appropriate fire extinguishers should always be readily available. They may remain on the fuelling vehicle, if they are carried in open housings or in racks with quick opening fastenings.

5.5.2 The recommended fire extinguisher is a 9kg BC dry powder extinguisher – sodium or potassium bicarbonate powders. These are the most suitable for liquid and gas fires and are therefore recommended for most fuelling applications.

Note: *ABC type multi-purpose mono ammonium phosphate powders are not recommended for aviation fuelling operations, as they can leave sticky and corrosive residue on surfaces when discharged.*

Extinguishers should be maintained and certified serviceable in accordance with the relevant recognised standards. Fuelling personnel should be trained on how to use extinguishers effectively and know where they are located.

5.6 Safety zones

Safety zones around hydrant pits and pit couplings are to be maintained while ~~whilst~~ in use.

6. Fuelling Procedures

Note: *Any published procedures by the fuelling company and any manufacturer's manual instructions on fuelling must be strictly followed.*

6.1 Precautions

6.1.1 The operator or the overseer should ensure that the following precautions are observed during the fuelling of any aircraft:

(a) Except for the provisions of section ~~paragraph~~ 8.5, aircraft engines should be stopped, with the ignition and starter switches placed on the "OFF" or "SAFE" position, before fuelling starts. Fuelling with engines running (hot fuelling) should not be conducted unless otherwise approved by CAA. If such a procedure is approved, the location and/or timing of the fuelling process are to be agreed between the aircraft operator, the fuelling company, and the airport authority, if appropriate (preferably in writing).

(b) No smoking, or the use of a naked flame, should be permitted on the apron or within 15 metres of the aircraft, the fuelling system or fuelling equipment[7]. If any naked flame device has to be used in these circumstances (outside these recommended distances), its use should be strictly controlled in accordance with locally approved safety procedures. It should be noted that most major airports and airfields in New Zealand have specific council airport bylaws in this regard, which must be adhered to, and may be significantly more restrictive than the recommendations in this AC.

(c) "No Smoking" signs or symbols should be displayed in prominent positions near the aircraft and fuelling vehicles throughout the fuelling operation. These symbols may be painted onto the sides of the fuelling vehicles.

6.2 General procedures

6.2.1 Personnel responsible for fuelling aircraft should take into account the following general procedures:

(a) Ascertain fuelling requirements – quantity and grade required.

(b) General aircraft servicing such as baggage handling and catering services and any other associated services may be carried out during fuelling operations. However, if obvious defects develop in motorised units operating within 6 metres of fuelling operations, the faulty units should be stopped immediately during fuelling operations.

(c) Operational problems can arise through the unsuitable location of the aircraft, due to misalignment of the aircraft in the parking bay, or by inappropriately located hydrant pits. In these cases, steps should be taken to arrange for the aircraft to be realigned or relocated.

[7] CAA's recommendation is based on Australian Civil Aviation Order 20.9, Para 4.4(as amended).

(d) Fuelling personnel should not operate aircraft fuel system controls (except as provided in section ~~paragraph~~ 4.4). The aircraft operator is responsible for determining the volume of fuel to be loaded and to instruct fuelling personnel accordingly. The operator is also responsible for manipulating aircraft tank valves and switches, drip and dip sticks and to finally check the security of tank fill caps, covers and components. If requested, the fuel company may advise on the density (specific gravity) of the fuel being delivered to enable any associated calculations to be made.

6.3 Hydrant systems – underwing

6.3.1 In addition to the 'general procedures' in section ~~paragraph~~ 6.2, the following sequence is recommended when the hydrant pit cover is removed:

(a) the grade of fuel from the hydrant pit and dispenser should be checked before the connection is made to the pit

(b) the visibility of the hydrant pit and dispenser should be improved by the use of a high visibility flag, safety cones or other acceptable method, during daylight hours

(c) the hydrant pit and dispenser should be suitably illuminated – usually via local tarmac lighting, when dark or at night

(d) follow the sequence set out below in respect of hydrant dispensers or servicers:

(1) if grounding is required, follow the procedure set out in section ~~paragraph~~ 4.2

(2) bond the hydrant dispenser to the aircraft

(3) if required, attach a lanyard to the pit valve, and extend the lanyard away from the fuelling position and the aircraft

(4) remove any dirt or moisture on the pit valve adaptor and hydrant coupler

(5) connect the hydrant coupler to the hydrant pit valve, and the delivery hose(s) to the aircraft. Each joint operation should have only one sequence which will be agreed by all participants and incorporated into a written fuelling procedure

(6) open the hydrant coupler and adaptor if it is manually operated

(7) activate the deadman control to start delivery

(8) carry out required fuel samples from dispenser in accordance with refuelling operations manual and procedures

(9) follow the above sequence in reverse when fuelling ends

(10) whenever the dispenser is left unattended (e.g. for signing the fuel receipt) the hydrant pit valve or hydrant coupler should be closed

(11) dust caps should be fitted to the pit valve adaptor and dispenser couplings at all times when not in use.

6.4 Fuellers – underwing

6.4.1 In addition to the general procedures in section ~~paragraph~~ 6.2, the following sequence is recommended:

(a) if grounding is required, follow the procedure set out in section ~~paragraph~~ 4.2

(b) bond the fueller to the aircraft

(c) connect all delivery hoses to the aircraft

(d) activate the deadman control to start delivery

(e) carry out required fuel samples from fueller in accordance with refuelling operations manual and procedures

(f) at the conclusion of fuelling, the reverse sequence should be followed.

6.5 Overwing fuelling

6.5.1 In addition to the procedures for underwing fuelling, the following further measures are required to ensure that the correct grade of fuel is delivered when using an overwing (trigger) nozzle.

(a) Personnel responsible for fuelling should never assume what the fuel grade is. Confirm the grade between you and the customer. Whenever possible, have in writing what the type and grade of fuel that should be provided.

(b) Before fuelling starts, fuelling personnel should check that the grade requested is the same as the grade marked on the aircraft, adjacent to the tank filler cap, and the same as the grade marked on the overwing fuelling nozzle.

Note:

(i) If there is no grade marking on the aircraft, fuelling should not start until the pilot or responsible ground servicing personnel has confirmed the grade of fuel required.

(ii) If the grade marking on the aircraft is different to that of the fuelling equipment, fuelling should not start until the discrepancy has been fully investigated and resolved.

(c) For Avgas overwing fuelling, nozzles with a maximum external diameter of 40mm should be used.

(d) For Jet A-1 overwing fuelling, nozzles with a minimum external diameter of 67mm should be used.

Note: *Certain jet fuel (Class 3.1C) aircraft types may have filling orifices which are too small to accept the standard diameter Jet A-1 nozzle, necessitating the use of a smaller diameter nozzle adapter.*

6.5.2 The following additional precautions are applicable for overwing fuelling.

(a) Loose articles should not be carried in caps, jackets or shirt pockets as these might fall into aircraft tanks.

(b) Hoses should be routed over the leading edge of the wing (and not the trailing edge) in such a manner that avoids the possibility of damage to the aircraft. Ladders and wing mats should be used as appropriate to avoid damage to the aircraft. Care should be taken in positioning ladders to avoid damage to the aircraft caused by settling while ~~whilst~~ product is being loaded. Wing mats should be positioned so that the fuel grade identification remains visible at all times.

(c) Overwing nozzles should be held open manually and should never be wedged open.

6.6 Maintenance and servicing of aircraft during fuelling or defuelling operation

6.6.1 During the fuelling operation, the pilot-in-command or overseer, as appropriate, should only permit maintenance, testing, servicing or cabin replenishment within the fuelling area subject to the following conditions.

(a) Ground power units should not be started, connected, their switches operated, or disconnected during fuelling. These actions must be completed either before refuelling or after the refuelling process is completed.

(b) The operation of aircraft combustion heaters, integral cabin heaters, wing, tail and surface heaters should not be permitted.

(c) The operation of aircraft radar transmitters should not be permitted.

(d) Maintenance, repair, or testing of the aircraft radio, radar and electrical equipment should not be permitted when the aircraft is being fuelled with class 3.1A fuel, except that switches necessary for the fuelling operation and lighting may be used.

(e) Functional checks may be carried out on aircraft radio, radar receivers and electrical equipment when class 3.1C fuelling is being carried out, but maintenance should be limited to the exchange of complete units.

(f) Maintenance, testing and functional checks other than those already detailed in ~~paragraphs~~ (b), (c), (d) and (e) above may be carried out when class 3.1A or class 3.1C fuelling is being carried out, except that work which may create sources of ignition, especially in the vicinity of aircraft fuel tanks or fuelling equipment, may not be carried out.

(g) Electric hand lamps or flashlights used in the immediate vicinity of the fuelling operation should be of a flame proof or safe design.

(h) The jacking of aircraft such as for wheel changes on either side must not be permitted when refuelling equipment or personnel are under the wing.

6.7 Refuelling in remote locations

6.7.1 Refuelling in remote locations exposes operators to increased risk in various areas, such as:

a) multi transfer fuelling cycles

b) contamination of fuelling equipment while ~~whilst~~ in transit and during aircraft arrival

c) miscellaneous fuelling equipment causing contamination issues

6.7.2 Multi transfer fuelling cycles may consist of transferring fuel between any of the following storage methods:

a) commercial suppliers

b) operator’s site tanks

c) fuel trailers

d) drums

e) jerry cans

6.7.3 Each time a fuel storage tank is opened for the purpose of fuel transfer operations, it represents an opportunity for contamination to occur. No storage tank should be opened prior to ensuring that comprehensive cleaning of the area surrounding the filler port is carried out. All operations where fuel is decanted between storage containers should be carried out using a suitable pump and preferably through micronic filtration. Further, anytime fuel is transferred between storage tanks or to an aircraft, operators are to check for fuel contamination in accordance with the guidance material provided in section ~~paragraph~~ 4.8 of this AC.

6.7.4 Prior to filling or using the fuel contained within, ensure that all equipment that is used to store or transport fuel in remote locations is of the appropriate standard and is checked for serviceability and cleanliness in accordance with the relevant parts of this AC ~~advisorycircular~~.

6.7.5 Fuelling equipment that is used to facilitate easy transfer of fuel, such as jerry can filler extension tubes, must be of an appropriate standard, configuration and cleanliness. In particular, tubes that are held to Jerry Cans with tape of any kind are prohibited as they have been known to detach and be found later in tanks. In an effort to ensure that any contaminants are cleared from the fuelling equipment nozzle prior to fuelling, fuelling staff should discharge the first fuel out of the nozzle into a container to be discarded.

6.7.6 Take care to correctly identify the type and quality (fuel does go stale) of the fuel before refuelling from drums. Ensure that the pump is fitted with a clean and serviceable filter (one that will filter particulate matter, as well as absorbing water). Corrosion products (rust), water and dirt can all be a problem when fuel is stored in drums. It is most important that the fuel delivery line incorporates a filter of five microns for avgas or 1 micron for jet fuel or less with the ability to separate both water and other contaminants. Fuel suppliers can provide or recommend suitable filters for this purpose.

Note: *A chamois cloth, once traditionally used as a filter, should not be used, as it can be a potential source of static charge. Fuel drums should be stored on their side with bungs and vents at three o'clock and nine o'clock positions, with the top of the drum (with the openings) lower than the bottom. This will minimise any 'breathing' (air and moisture exchange from outside) through the bungs and vents. A partly filled drum is more likely to contain moisture because of increased 'breathing'.*

6.7.7 When opening a drum:

(a) Stand the drum upright but tilted slightly, and chock it with the high side positioned at 12 o'clock, the bung at 3 o'clock, and the vent at 9 o'clock. This minimises water or dirty fuel on the outside of the drum from reaching the openings.

(b) Allow the drum to stand undisturbed for at least 10 minutes prior to fuelling to let any internal contaminants settle out.

(c) Proper bonding is critical. Connect the bonding lead to an unpainted surface on the drum and to the aircraft designated bonding point before opening any fuel caps, and leave it in place until all fuel caps have been replaced.

(d) Open the pumping bung and vent then perform a visual inspection of the condition of the drum using a fuel safe light source. Fuel in drums showing signs of internal deterioration

should not be used. Next, carefully withdraw and check a fuel sample from the drums low point using a thief tube or specially designed suction device.

(e) Ensure that the pump standpipe cannot reach the lowest point in the drum - any small amount of water or dirt will thus remain in the drum. The last few litres of fuel should not be needed badly enough to risk using it.

6.7.8 The practice of using bleed air from the compressor of an aircraft turbine for the purpose of pressurising the fuel drum can only be considered safe if the following points are observed:

(a) any plumbing and other permanent attachments to the aircraft designed and fitted to achieve such pressurisation, must be properly authorised as such by an approved modification

(b) there should be a means of filtering all contaminants, removing moisture and regulating the pressure of the compressor bleed air prior to its entry to the drum

(c) the bleed air pressure to the drum should be reduced by an acceptable means to below 2.5 psi.

6.7.9 Take care not to exceed the allowable maximum differential pressure across the filter element so that the excessive pressure does not render the filter ineffective. It is therefore important to ensure that the stand pipe is positioned clear of water deposits which may be presented in the bottom of drums.

6.7.10 Fuel suppliers are well aware of the problems of refuelling from drums in remote areas and have indicated their willingness to assist operators in the adoption of safe refuelling practices. Technical information in the form of bulletins and leaflets is readily available from most suppliers.

7. Defuelling Procedures

Note: *Any published procedures by the fuelling company and any manufacturers' manual instructions must be strictly followed.*

7.1 Defuelling procedure

7.1.1 It may, from time to time, be necessary either to off-load fuel from an aircraft after completing fuelling for subsequent aircraft fuel load adjustment, or to completely off-load all fuel, usually at the airline overhaul base, to permit maintenance work to be carried out.

7.1.2 Both operations are designated defuelling and the procedures to be followed during defuelling are similar to those which apply to fuelling.

7.1.3 To protect the quality of the fuel in the fuelling equipment from being contaminated by the fuel off-loaded from the aircraft, the following procedures should be adopted before defuelling begins:

(a) The grade of fuel contained in the aircraft tank should be established by:

(1) taking samples for a visual check and, if jet fuel, water check by chemical detector

(2) identifying the grade of fuel uplifted on the two previous supplied fuelling

Note: *The aircraft operator should supply this information.*

(3) the aircraft operator must confirm that the previous two fuel receipts have not been dosed with biocides, FSII or other fuel additives.

(b) If there is any reason to suspect the quality of the fuel, any fuel off-loaded should be segregated and subjected to a certificate of analysis test that must be successful before returning the fuel to operating storage or another aircraft.

(c) If the quality of fuel is not suspect, or it has passed the applicable tests, it may be delivered to an aircraft of the same airline/operator or to another airline/operator with written permission.

(d) If the aircraft contains a mixture of Jet A-1 with Jet A or Jet B or Jet Fuel of East European origin or fuel of unknown origin or specification, the fuel should be disposed of, unless the airline/operator concerned agrees that the fuel can be returned to the aircraft. The product which has been defueled for load adjustment purposes should, whenever possible, be returned to an aircraft of the same airline.

(e) Defueled fuel may be received into segregated storage owned and operated by the aircraft operator until redelivery to the aircraft concerned or to an aircraft of the same airline. Returning of defueled stock to airport fuel storage depots is no longer an acceptable option. Prior to filling, any facility, tank or vessel that is used to receive fuel during defuelling operations is to be inspected for meeting the appropriate standards of construction and condition that are contained in this AC. Storage vessels that do not meet these requirements should not be used.

(f) When a fueller has contained fuel of suspect quality or unknown provenance, it should be drained and inspected internally for cleanliness and absence of any remaining fuel. All drain points should be purged to clear pipework and components (filters, pumps, etc.) of the suspect fuel. The filter elements must be replaced. The fueller should then be filled to capacity and 1,000 litres should be delivered at maximum flow rate through each hose back into a storage tank containing at least 20,000 litres of the fuel grade.

(g) Fuel containing FSII additive or biocides must not be redelivered via filter monitor elements due to the possibility of filter media migration.

Note: *For compliance with aviation fuel specifications and standards, refuelling companies are not permitted to handle or dose fuels with biocides.*

8. Fuelling Procedures under Certain Situations

8.1 Fuelling while aircraft mounted auxiliary power units (APU) are in operation

8.1.1 An auxiliary power units (APU) exhaust discharging outside fuelling zone[8]:

(a) fuelling unit should be located as far from the APU exhaust as possible

(b) the APU may be started and stopped during the fuelling operation without notification

(c) if fuel spills, the APU should be stopped immediately and remain stationary until spillage is removed and there is no danger from inflammable vapours.

8.1.2 An APU exhaust discharging into fuelling zone:

(a) The APU should be started before the covers of the fuelling connections and hydrant caps are removed or any fuelling connections made.

(b) If the APU is stopped during the fuelling operation; it should not be started until the flow of fuel has stopped.

(c) When the APU discharges from the side of the aircraft, if possible, the fuelling unit should be positioned on the opposite side of the aircraft to the discharge. If this is not possible, the fuelling unit should be positioned out of, and at the maximum practicable distance from, the exhaust stream.

(d) If fuel spills, stop the APU immediately and remain stationary until spillage is removed and there is no danger from inflammable vapours.

(e) Where the APU exhaust is directly across the upper surface of the aircraft wing, do not carry out overwing fuelling while APU is running.

8.1.3 An APU in engine nacelle on fuelling side of aircraft:

(a) The fuelling company should develop their own specific procedures with regard to fuelling this type of aircraft.

8.2 Fuelling while ground power units (GPU) are in operation

8.2.1 Position the ground power units (GPU) and associated cabling at least 6 metres away from fuelling vehicles and clear of wing tank vents.

8.2.2 Do not start, connect, switch on, or disconnect the GPU during the refuelling process. These actions must be completed either before refuelling or after the refuelling process is completed.

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[8]Fuelling zone/area: This is made up of areas with a radius of at least 3 metres, or more (depending on the installation)authorities, from filling and venting points on the aircraft, hydrant pits, fuelling vehicle and its hoses in use.

8.2.3 If fuel spills, the GPU should be stopped immediately and should remain stationary with all electrical circuits and switches left untouched until the spillage is removed and there is no danger from inflammable vapours.

8.3 Fuelling with air conditioning units in operation

8.3.1 Fuelling operations may be carried out subject to the same conditions as those applicable to general aircraft servicing, with the exception that, if fuel spills, the unit should be switched off. This is to prevent the possibility of flammable vapours being drawn into the aircraft passenger compartment or avionics bay.

8.4 Fuelling with one aircraft engine running

8.4.1 Fuelling of an aircraft, which has one propulsion engine running, is a non-routine operation and requires very strict safety precautions[9].

8.4.2 The following procedure applies specifically to underwing fuelling.

(a) Fuelling with one engine running should not be performed unless the operator's authorised representative requesting this kind of operation accepts, in writing, complete responsibility for the operation.

(b) A qualified representative from the operator should then supervise the fuelling operation.

(c) Due to its non-routine nature, the operation should be reviewed ahead of time by the operator and the fuelling company representatives. The review should include documented risk assessment, HAZOP study and completion of a permit to work.

(d) The aircraft should be positioned at a distance of at least 50 metres away from the passenger loading area of the terminal and any other building or other aircraft.

(e) The aircraft should be headed into the wind.

(f) Where one-man fuelling would normally be carried out, an additional supervisor or senior fuelling hand should also be present.

(g) Fuelling is not to be started until all passengers have vacated the aircraft and are kept at a distance of at least 50 metres away.

(h) All personnel involved in the fuelling operation should be clear of the running engine, and all other personnel not directly needed for the fuelling operation should maintain a safe distance of at least 50 metres from the aircraft.

(i) Properly manned mobile fire-fighting equipment, with the engine running, should be standing by the aircraft.

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[9] **Overwing Class 3.1A fuelling with one engine running is not permitted under any circumstances.** For other fuel types, the procedure should be used only when an aircraft engine cannot be restarted because of inoperative ground aircraft starting equipment. The overseer should ensure that the fuelling operation with one engine running, as requested by the operator, is within the scope of the current airport regulations. Under no circumstances may fuelling take place on the same side of the aircraft as that where an engine is running, or on a Class 3.1A fuel helicopter, with the engine running.

(j) Fuel will be loaded on the side opposite to that of the running engine with the fuelling equipment positioned a maximum (sensible) distance from the running engine.

(k) When additional fuel is required on the other side of the aircraft the operation should be carried out in the following order:

(1) remove the fuelling equipment from the side where the fuelling has just been completed

(2) reposition the fuelling equipment at least 50m from the engine to be started

(3) operator aircraft personnel to start the engine on the side which has just been fuelled

(4) operator aircraft personnel to shut down the engine of the side to be fuelled

(5) position fuelling equipment adjacent to the wing to be fuelled at a maximum (sensible) distance from the running engine

(6) load fuel.

8.5 Operation of aircraft engines and APU within the fuelling area

8.5.1 The pilot-in-command and/or overseer as designated by the aircraft operator should ensure that no hazard is presented to fuelling equipment, its operation or to fuelling personnel during the starting of engines or taxiing of aircraft, especially due to the efflux from turbine engines. In the case of the fuelling equipment or personnel to the rear of, and within a 15° arc either side of the exhaust outlet axis, the engines should not be operated unless the engine is at a minimum distance (listed in Appendix 1).

8.5.2 As aerodromes or airports serve a large variety of aircraft types, depending on prevalent aircraft engine type, the minimum distances may be increased or decreased if agreed by the affected parties.

8.5.3 The operation of aircraft engines including aircraft-borne APUs within the fuelling area is not recommended, except when the engines (or APUs) are tail-mounted and the fuel to be uplifted is class 3.1C, or the express approval of the relevant fuelling agency (or aerodrome (as applicable) and aircraft operator has been granted.

8.5.4 In addition, if the aircraft-borne APU is not tail-mounted, it may be operated within the fuelling area when the fuel to be uplifted is class 3.1C providing the APU is started before the filler caps are removed and fuelling connections made.

8.5.5 If an aircraft-borne APU is stopped for any reason during fuelling, it should not be restarted until the fuel has stopped flowing, the refuelling vehicle is disconnected and moved away, and there is no risk of igniting fuel vapours.

8.5.6 Operators are responsible for the following:

(a) ensuring that personnel concerned with the starting of aircraft engines near fuelling operations are fully conversant with correct operation of the aircraft's fire extinguishing system

(b) ensuring that during the starting of aircraft engines, an approved fire extinguisher is available for immediate use

(c) ensuring that during the starting of aircraft engines using class 3.1A fuel with passengers aboard the aircraft, equilibrium of the aircraft is maintained. Maintaining the equilibrium

is ideal especially if an emergency arises and passengers need to leave by one exit. A manned passenger loading ramp should be readily available in an emergency.

8.6 Fuelling/defuelling with on board/embarking/disembarking passengers (ONLY Class 3.1C fuel)

8.6.1 Fuelling or defuelling involving passengers may be carried out following the accepted procedures in an aircraft operator's exposition. Refer to ~~Civil Aviation~~ rules 121.91, 125.73, and 135.73 provided the conditions listed below are satisfied:

(a) Such fuelling or defuelling is permitted by the local airport regulations and is requested by the aircraft operator, preferably in writing.

(b) The aircraft operator accepts sole responsibility for ensuring that:

(1) The local airport regulations relating to fuelling or defuelling are carried out.

(2) Instructions are issued to its employees for the safety of all passengers during fuelling or defuelling and that these instructions are strictly observed.

(3) Passengers joining or leaving the aircraft are moved under the supervision of a responsible person employed by the operator over a safe route, and are not allowed to smoke, linger, use mobile phones, cameras, or any other non-intrinsically safe devices, and are kept at a maximum distance from the fuelling operation.

(c) Fuelling or defuelling should stop immediately in a hazardous situation, such as spillage, or if the procedures set out in this AC are not followed correctly which could result in a dangerous incident.

(d) The following special safety measures should be observed when passengers are to remain on board during aircraft fuelling.

(1) Where passenger loading stairways are used they should be positioned at each passenger door normally used at that airport and these doors should be kept open, except these doors may be closed during inclement weather, but they should be kept unlocked and free to open, with the stairways remaining in position. Where aerobridges are used, only those doors served by the aerobridges at that location need be opened.

(2) Access to exit doors and aisles in the aircraft should be kept unobstructed and any doors between passenger compartments kept open.

(3) One crew member or a suitably trained person should be present at each passenger main exit door in use and additionally in each other occupied compartment.

(4) Crew members should advise passengers that fuelling will take place and that proper precautions are being taken to ensure their safety. The crew members will ensure that the "No Smoking" sign is displayed in each compartment, that the seatbelt signs remain off (not illuminated), passengers are advised not to fasten their seatbelts until the refuelling is complete, all exits are clearly indicated by a reflective marker or lights, and all exit lights are illuminated or armed.

(5) If an abnormal concentration of fuel vapour is detected in the cabin, or any other condition that may constitute a hazard occurs, the responsible crew member should advise the fuelling personnel immediately.

(6) Crew members are to assist the evacuation of passengers in the event of fire or when any other hazard exists and when necessary should utilise appropriate emergency evacuation slides on their own initiative.

(7) The equilibrium of the aircraft should be maintained if all passengers leave by one exit.

(8) For a marine aircraft not moored to a pontoon or jetty, adequate means of water transport should be stationed at the cabin exit door.

(e) When passengers are to embark or disembark during fuelling the following special additional safety measures should be observed:

(1) Passengers should be warned not to smoke.

(2) Passengers should be routed by a roped off or clearly marked track, clear of the fuelling equipment, or supervised by a responsible person employed by the operator on their journey to and from the aircraft.

(3) Suitable measures should be taken to prevent spark hazard from passengers' shoes within the fuelling area.

(f) Passengers should not be allowed to remain on board helicopters during fuelling/defuelling operations.

8.7 Auxiliary plant, vehicles and electrical equipment

8.7.1 Internal combustion engines used in association with auxiliary plant and vehicles powered by internal combustion engines should not be operated within the fuelling area unless:

(a) when refuelling with class 3.1A fuel or 3.1C fuel, the spark plugs of these engines have been encased in an approved screening device and effective flame traps are fitted on air intakes and exhaust systems

(b) the equipment is subject to regular inspection and maintenance, or the entire exhaust system (excluding exhaust valve gear) inspected at not greater than 90-day intervals and the integrity of the complete system verified.

8.7.2 Do not start, connect, switch on, or disconnect a GPU during refuelling. These actions must be completed before or after refuelling is completed.

8.7.3 Where an electric motor, portable electrical appliance or ground supply unit is operated within the fuelling area, all electrical apparatus on the unit should be flame proofed in accordance with AS/NZS 60079.14~~, *Explosive Atmospheres Pt 14 Design Selections Erection and Initial Specification*~~.

8.7.4 Operators should make sure that vehicles and fuelling equipment are maintained to satisfactory safety standards.

8.7.5 Do not start ground equipment engines in the vicinity of the aircraft being refuelled, during fuelling until the flow of fuel has ceased and there is no risk of igniting fuel vapours, venting from the aircraft.

8.7.6 Ground equipment engines should also not be operated within 3 metres horizontal radius of an aircraft fuel venting system. The area also includes all that space encompassed vertically below the horizontal exclusion zone.

8.8 Fuelling on aircraft having fuel tanks with inert gas system (nitrogen generation system)

8.8.1 Modern generation transport category aircraft may be fitted with fuel tanks having a nitrogen generating system. This nitrogen generating equipment is dangerous as nitrogen is colourless and odourless. The generated nitrogen decreases the oxygen in the air remaining within the tank, safeguarding against the likelihood of an explosive mixture. However, the resultant gaseous mixture when vented is unhealthy and may cause hypoxia, dizziness, nausea, and in extreme cases unconsciousness and possible death.

8.8.2 While fuelling or defuelling aircraft which have fuel tanks fitted with nitrogen generating equipment, make sure that any warning instructions associated with such systems (typically in the main wheel well, centre fuel tank and air conditioning bay) are read and obeyed by fuelling operators. The aircraft operator should be approached to assist in identifying any hazards and procedures to be followed when dealing with such systems.

8.8.3 An aircraft operator is responsible for educating and training fuellers regarding features of the aircraft used by the operator relating to fuelling/defuelling operations and special precautions to be taken during fuelling operations.

9. Health and Safety and Risk Management

9.1 Harmful effects of aviation fuels on health - precautions

9.1.1 To reduce health hazards when handling aviation fuels, observe the following precautions:

(a) Make sure you are familiar with the hazards and precautions indicated in the relevant Material Safety Data Sheet.

(b) Immediately wash any part of the body that comes into contact with aviation fuel, using a waterless hand cleaner, followed by soap and water. Never wear fuel-soaked clothing.

(c) Take care in handling hoses, cans and funnels wet with aviation fuel.

(d) Clean and dry any tools that have been in contact with the fuel.

(e) Dispose of waste that has been in contact with fuel appropriately. Never put fuel-wet rags in pockets.

(f) Wash hands after contact with aviation fuel before putting food, cigarettes or anything else in the mouth.

(g) Wear appropriate protective clothing and use appropriate equipment (e.g., ear, eye and head protection, non-electrostatic generating clothing, proper footgear and gloves).

(h) Use a safe solvent and preferably not aviation fuel for washing/cleaning of tools.

(i) Launder or dry-clean soiled clothing.

(j) Carefully wipe sample containers of aviation fuels with a rag before touching with bare hands.

9.2 Personal protective equipment (PPE)

9.2.1 It is important from a Health and Safety perspective that the correct personal protective equipment (PPE) is worn during any fuelling/servicing/defuelling operations.

9.2.2 Wear a face visor or goggles in circumstances where eye contact can accidentally occur. If skin contact is likely, wear impervious protective clothing and/or gloves.

9.3 Exposure of the body to aviation fuel actions

(a) If any aviation fuel is swallowed, seek medical attention. Do not induce vomiting.

(b) If exposure to vapour, mists, or fumes causes drowsiness, headache, blurred vision or irritation of the eyes, nose or throat, remove the source of contamination or move the victim to fresh air. Seek medical attention.

9.4 Risk management

9.4.1 Management of risk is the responsibility of all industry participants, whether private or commercial operators. Many serious incidents or accidents that are caused by fuel contamination problems occur in a context of previous minor incidents going either unnoticed or unmitigated. Further, even when incidents are dealt with, often protective measures that are required to prevent reoccurrence are either insufficient or completely missing. A good example of this is when fuel tank contamination occurs, often the response is to make the necessary repairs to the aircraft, but neglect to look at what systems or processes failed to prevent the contamination in the first place.

9.4.2 All operators of aircraft are reminded of their obligations as aviation document holders to comply with section 13(a) of the Civil Aviation Act 1990:

> ***13 Duties of pilot-in-command***
>
> *The pilot-in-command of an aircraft shall:*
>
> *(a) be responsible for the safe operation of the aircraft in flight, the safety and well-being of all passengers and crew, and the safety of cargo carried; and…*

9.4.3 Appropriately managing the risk to the quality of fuel that enters the aircraft has a material impact on both the safe operation of the aircraft in flight and the safety and wellbeing of all passengers and crew. Therefore, all pilots are expected to ensure that any instances of contaminated fuel entering an aircraft are appropriately reported and dealt with.

9.4.4 For operators that are obligated to have a safety management system (SMS) approved under ~~Civil Aviation Rule~~ Part 100, it is expected that any instances as described above are appropriately managed through the provisions in their SMS. Incidents of fuel contamination impact on virtually all of the SMS elements that are identified in ~~AC~~ AC100-1 and it is expected that:

(a) evidence of these elements being applied is documented for any reported instance

(b) the risk of fuel contamination is effectively treated through the operator's hazard/risk register.

Appendix 1: Minimum Distance from Refuelling Activity for Engine Operation

A1.1 An aircraft engine should not be started or operated while ~~whilst~~ refuelling is underway:

(a) within 5 metres (17 ft) of any sealed building; or

(b) within 8 metres (25 ft) of other aircraft; or

(c) within 15 metres (50 ft) of any exposed public area; or

(d) within 15 metres (50 ft) of any unsealed building in the case of an aircraft with a maximum take-off weight exceeding 5700 kg (12566 lb); or

(e) within 8 metres (25 ft) of any unsealed building in the case of an aircraft with a maximum take-off weight not exceeding 5700 kg (12566 lb).

A1.2 Turbine engines, in addition, should not be operated within the appropriate distance specified below of any other aircraft, fuelling equipment or exposed public areas which lie to the rear of and within a 15º arc either side of the exhaust outlet axis of that engine.

Engine type	**Power condition**	**Minimum distance metres**
Turbo-prop	At or below normal slow taxiing power	15 (50 ft)
	At power used to initiate movement of a stationary aircraft	23 (75 ft)
Turbo-jet	At or below normal slow taxiing thrust	30 (100 ft)
	At thrust used to initiate movement of a stationary aircraft	46 (150 ft)

Note: *Fuelling equipment does not include equipment and outlet points of an installation located below ground level when the equipment is stowed and covering hatches are in place.*

Appendix 2: Dipsticks

A2.1 Fabrication of dipsticks

A2.1.1 Dipsticks should be fabricated from a non-magnetic material, finished so that they are unlikely to damage the fuel tanks or cells of the aircraft they are to be used on.

A2.1.2 Many dipsticks are fabricated out of wood. It is preferable the dipstick is not painted, however, if it is painted, ensure that it is a type of paint that will not be affected by the fuel and the paint is unlikely to chip or flake. Ensure that the surface finish will not facilitate excessive creeping of the fuel level which may lead to over indication of the fuel quantity.

A2.1.3 Many dipsticks are circular, however the use of a rectangular or square section may make it easier to mark and will more easily allow different units of measurement to be included.

A2.1.4 The top end of the dipstick should be fabricated so that the dipstick cannot fall into the tank, the dipstick should be fitted with a "REMOVE BEFORE FLIGHT" streamer.

A2.2 Calibration of dipsticks

A2.2.1 All dipstick markings should be permanent, preferably engraved, and should include the aircraft's registration letters and the units of measurement. While the aircraft may appear to be the same, it is quite possible that the same type of aircraft may have different shaped or sized fuel tanks – therefore aircraft dipsticks should not be interchanged between aircraft.

A2.2.2 In addition to the manufacturer's preferred markings, complementary scales in differing units of volume or weight may be added on separate surfaces of the dipstick, providing no chance of confusion exists.

A2.2.3 If the aircraft has tanks with differing capacities, a separate dipstick should preferably be used for each tank location, rather than to calibrate a common dipstick. Each dipstick should be clearly marked to indicate which tank it relates to.

A2.2.4 The dipstick should be marked to indicate "empty" when the tank contains the unusable fuel quantity stated in the flight manual. In other words, the quantity indicated by the dipstick should be usable rather than total.

A2.2.5 To establish the "empty" mark, the fuel system should be drained at its lowest drain point. Allowing for any undrainable fuel, add the quantity of fuel required to make up "unusable" fuel. With the aircraft in the attitude that it would be in when the dipstick is used, mark the dipstick "empty" at the fuel level indicated. Calibrate the remainder of the scale by adding known additional quantities of fuel and marking the dipstick accordingly.

A2.3 Dipstick use

A2.3.1 For most aircraft the dipstick should be held vertically while making fuel quantity readings. However, some aircraft may have unusual filler neck geometry necessitating special techniques for which instructions should be supplied.

A2.3.2 The dipstick should never be forced or allowed to drop onto the bottom of the tank, as damage may occur or paint flakes may be dislodged.

A2.3.3 Dust and debris should be wiped off the dipstick with a clean cloth before its insertion into the fuel tank.

A2.4 Stowage

A2.4.1 When not in use, the dipstick should be kept in a stowage receptacle, where it cannot come adrift during flight.

A2.4.2 Stowage should preferably be in a specially made pocket so that the dipstick is protected from contamination and is readily accessible from the ground outside the aircraft. The stowage pocket should have suitable provision (e.g. a flap or straps) to retain the dipstick.

A2.4.3 Before stowage, the dipstick should be wiped dry so that residual fuel vapour will not cause discomfort or danger to the aircraft occupants.