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**OPERATION OF AIRCRAFT
SAFETY
PRECAUTIONS TO BE OBSERVED DURING AIRCRAFT FUELLING OPERATIONS**

This AIC replaces AIC 21.27 dated 15-04-1996.

1. Purpose. This advisory circular provides information on fire preventative and other safety measures which should be observed during fuelling operations.

2. General

2.1. It is not the intent of this circular to replace company procedures which are tailored to meet requirements imposed by special equipment or local regulations. It is devoted chiefly to highlighting procedures and practices which, if not strictly complied with or corrected, may contribute to unsafe conditions and increase the fire probability factor.

2.2. The three factors: fuel, heat or ignition and oxygen - commonly referred to as the fire triangle, will be examined to determine methods of controlling or eliminating them to prevent fire.

NOTE: A fire tetrahedron has been proposed to illustrate chemical chain reaction in combustion processes.

2.3. Airline, aircraft manufacturing and fuel servicing company manuals, deal in detail with the fire hazards. The safety regulations associated with aircraft fuelling operations contained therein should be complied with.

3. Some fuel facts

3.1. Some facts concerning aircraft fuel are repeated herein to emphasise the effect on fire propagation.

Before aircraft fuel can be ignited, it must be:

3.1.1. converted to a vapour;

3.1.2. mixed in the correct proportion with air to provide the oxygen necessary for combustion; and

3.1.3. an ignition source must be present.

- 3.2. Fire is impossible if any one of the three factors making up the fire triangle is missing, or if the improper relationship between them exists, whether it is in a reciprocating engine cylinder, turbine engine combustion chamber or afterburner, or an open spill on the ground.
 - 3.3. The volatility, flash point and flammability limit of fuel affect its ignition and burning characteristics. Volatility is affected by changes in temperature and altitude, and atomisation or misting of the fuel.
 - 3.4. Turbulence or agitation of the fuel, such as may occur during tank filling operations, increases the probability of generating static electricity which may provide an ignition source.
 - 3.5. All petroleum fuels have flammability limits. Fuel-to-air mixtures above or below this flammability range are either too rich or too lean to support combustion.
4. Some methods of ignition and control. Some of the ignition sources and methods for eliminating or controlling them are as follows:
- 4.1. Smoking: Prohibit smoking in areas where fuelling operations are, or are likely to be, conducted.
 - 4.2. Open flames: Do not permit, in close proximity to where fuelling operations are being conducted, open flames from matches, cigarette lighters, flare pots, or similar open-flame lights; welding, cutting and blow torches; exposed flame heaters (including portable petrol or paraffin heaters), and exhaust from internal combustion engines.
 - 4.3. Sparks: Sparks are frequently created from electrical equipment being turned on or off and when being disconnected. These sparks can cause ignition if flammable vapours are present.

Prohibit the following during fuelling operations:

- 4.3.1. Installation or removal of batteries;
- 4.3.2. connection or disconnection of battery charges or ground power supply units;
- 4.3.3. connection or operation of ground power supply units, except at locations as remote from the fuelling point as possible and never under the aircraft wing;
- 4.3.4. the use of steel tipped or studded shoes or boots, electrical tools, such as drills, buffers, etc., in or near the aircraft;
- 4.3.5. operation, except in an emergency, of aircraft electrical switches which control units in the wing or tank areas not necessary to fuelling operations;
- 4.3.6. the use of photo flashbulbs within 3 metres of fuelling equipment;
- 4.3.7. unapproved flashlights or electrical hand lamps in hazardous locations near the fuelling point;
- 4.3.8. the use of high-frequency ground or airborne radar equipment, unless a separation of 15 metres and 90 metres respectively, between energised airborne and ground radar equipment is maintained;
- 4.3.9. tossing or dropping of tools and equipment or dragging metal ladders on the ramp area when fuelling operations are in progress;

- 4.3.10. the use of metal-wheeled equipment in the vicinity of the aircraft.
5. Power-operated ramp vehicle ignition and exhaust systems:
 - 5.1. Improperly maintained ignition and exhaust systems on these vehicles may cause short circuiting and arcing across electrical terminals and in the exhaust manifolds. It is imperative that fuelling crews report evidence of malfunction in these systems for immediate repair.
 - 5.2. Exhaust Gases: Conducting fuelling operations upwind from operating turbine or reciprocating engines is a preferred practice.
6. Hot metal parts: Overheated undercarriage assemblies, such as brake drums, may ignite dripping fuel or fuel mist. Refuelling should not take place until the heat has dissipated and it is confirmed that it is safe to proceed.
7. Stray electrical currents and static electricity: These are sources of ignition if present in a flammable fuel-to air mixture. Below, subparagraphs 7.1 to 7.3, inclusive, list sources of stray electrical currents, and subparagraphs 7.4 to 7.9, inclusive, list sources of static electricity:
 - 7.1. improperly made connections between ground power units and the aircraft;
 - 7.2. electrical shorts from electrical power sources to fuel system;
 - 7.3. cathode protection system frequently provided to reduce corrosion of underground lines to the tank bottoms;
 - 7.4. fuel flow in servicing hose. The greater linear fuel flows utilised to service jet aircraft, increase the static electric charge in the fuel servicing hose;
 - 7.5. free falling fuel through air in fill spout;
 - 7.6. turbulence in the fuel;
 - 7.7. flow of rain, snow, or dust across the aircraft surfaces;
 - 7.8. rubber-tyred vehicles;
 - 7.9. electrically charged atmospheres. During severe lightning and electrical storms, fuelling operations should be discontinued. Prevention of the presence of a flammable fuel-to-air mixture in areas adjacent to open fuel intakes is impossible;
 - 7.10. do not permit static electricity, which accumulates on the aircraft or in the fuel service equipment, to discharge as a spark. External sparking due to static or stray electricity can be reduced by providing an easy path for the electricity to follow through a conductive lead. Bonding, by equalising or draining the electric potential, prevents sparks.
8. Fuel spills: prevention and control
 - 8.1. Fuel spills are often the result of improper or careless operation of fuelling equipment and lack of preventative maintenance of the mechanical fuelling equipment. Therefore, it is imperative that operating personnel comply with the company procedures established to govern fuelling operations and reports any leakage of the equipment used during the fuelling operations to supervisory personnel.
 - 8.2. Self-discipline on the part of every man on the fuelling crew is required to prevent fuel spilling.
 - 8.3. Fuelling personnel must:

- 8.3.1. never leave the fuel nozzle unattended;
 - 8.3.2. never tie or wedge the nozzle trigger in an open position, or tie down dead man control valve lanyards;
 - 8.3.3. devote full attention to the fuelling operation; frequently check the amount of fuel in the tank to prevent overfilling;
 - 8.3.4. understand the operations of the automatic and dead man switches or shutoff valves in the aircraft fuel system; pre-check or verify their operating conditions; and constantly monitor their operations when using under-wing fuelling procedures;
 - 8.3.5. stop the flow of fuel immediately upon discovering leakage or spillage from the fuel servicing equipment;
 - 8.3.6. always ensure that the pump selector valve is in "OFF" position prior to changing nozzle from over-wing to under-wing, or vice versa, using the quick-disconnect coupling.
9. Training. Careful instructions in operating procedures are required for all personnel involved in fuelling to ensure safe performance of their duties. Perform fuel servicing only when:
- 9.1. personnel competent to perform this service are available;
 - 9.2. adequate manpower is constantly available to control the flow of fuel in case of an emergency.
10. Inspection programme
- 10.1. Initiate a continuing programme under the direction of a fuelling supervisor for monitoring fuelling operations to ensure compliance with safety requirements. This guidance is the concern of those pilots/crew members who are responsible for refuelling their aircraft, particularly at remote airfields where fuelling supervisors and/or aircraft maintenance personnel are not in attendance and where refuelling equipment used may be primitive.
 - 10.2. Direct particular attention in this programme to:
 - 10.2.1. The use of the correct type and grade of fuel and oil when refuelling each aircraft. Each aircraft is approved for operation using a particular type and grade of fuel and oil, and in some instances more than one type and grade of fuel and oil is approved for use. It is particularly important that BEFORE any refuelling operations on aircraft are commenced, that it is determined what type and grade of fuel and oil is being used by each aircraft which requires refuelling. It is an airworthiness requirement that the correct type and grade of fuel and oil approved for use in each aircraft be clearly marked at the filler point of each tank, together with each tank's capacity.
 - 10.2.2. The elimination of water and dirt (foreign matter) from petroleum based fuel. Water gains access to fuel in various ways (i.e. leakage, seepage, condensation, etc.) and it must be removed. Fuel tankers and dispensers are all fitted with filters and water separators, and these should be kept clean and sumps periodically drained. (Company requirements based generally on locality of equipment and prevailing weather conditions normally determine the frequency.)
 - 10.2.3. To avoid water condensation in aircraft fuel tanks/ cells, they should not be allowed to remain empty of fuel when the aircraft is not being operated, but should be refilled.
 - 10.2.4. Chamois leather filters are only effective for preventing the passage of water if they are thoroughly wet with petrol before fuelling is commenced. (Chamois leather filter are

often permitted to lie around on 200 litre fuel drums in the open and to gather dust and dirt. Care should be taken to ensure that chamois leather filters are always stored in a clean place when not in use, and if found dirty, thoroughly cleaned, and soaked in petrol before use.)

- 10.2.5. Only permit operation of refuelling equipment by qualified personnel.
 - 10.2.6. Adequate training of fuel service personnel in the proper use of available fire extinguishers and how to summon the aircraft fire and rescue service is essential.
 - 10.2.7. Always ensure that fuelling operations are conducted with sufficient qualified personnel, and that fuel servicing vehicles are not parked unattended, except when parked in designated parking areas.
 - 10.2.8. Avoid fuelling at site where the fuelling equipment or fuel tank vents are in close proximity to any building other than those parts of the building(s) constructed for direct loading or unloading of aircraft.
 - 10.2.9. Suitable precautions should be taken to prevent movement of the aircraft and fuel servicing equipment by setting the aircraft and vehicle brakes or using wheel chocks, or both.
 - 10.2.10. Always ensure that positioning of fuel servicing equipment during fuelling operations so that clear exit paths are maintained; in case of emergency, equipment can be driven away without the need to reverse, and ensure personnel exits are not obstructed. When fuel servicing equipment is parked for fuelling operations, no other vehicle or servicing equipment is to be positioned in a manner which will hinder its speedy removal in case of emergency.
 - 10.2.11. Prohibit parking and driving of catering and service trucks in close proximity or under aircraft wings during fuelling operations. Supervisory personnel should thoroughly instruct drivers of these vehicles as to the inherent hazards associated with fuelling operations.
11. Precautions must be taken when fuelling is performed with passengers still on board the aircraft, such as:
 - 11.1. Availability of passengers exits in the form of a stand, loading bridge or internal stairway;
 - 11.2. Qualified cabin attendants should be present;
 - 11.3. The aircraft "NO SMOKING" signs and "EXIT" lights should be illuminated.
 12. Smoking or use of open flames must be prohibited within the fuelling zone usually considered to be 15 METRES radially from any filling or venting points. Conspicuously display "NO SMOKING" signs to warn smokers of the HAZARDOUS areas, and rigidly enforce this rule.
 13. Extinguishers located in the vicinity of fuelling operations should be of a suitable type and properly maintained.
 14. Auxiliary power units (APUs) installed aboard aircraft may be operated during fuelling operations, provided in their design and installation adequate attention has been given to fuel vapour and ignition hazards which may be involved.
 15. Ensure proper bonding of fuel servicing equipment and aircraft before each fuel tank is opened, and throughout the entire fuelling process.

16. After refuelling an aircraft, fuel tank sumps should be checked by authorised personnel and any water found should be drained off. This is particularly important when refuelling equipment used is primitive or when fuel supply is suspect of water contamination.
17. Regarding the storage of fuel drums, 200 litre fuel drums should be stored on their sides and not standing upright. In this manner, rainwater will not seep into a drum in which the plug (bung) is not properly fitting. Ensure, when fuel drums are turned on their sides that fuel is not leaking from the plugs (bungs).
18. Wearing of clothing made of synthetic material is discouraged as it can produce sparks.
19. During the refuelling operation of small aircraft, if small containers are used, these should be of a conductor material and properly bonded to prevent arcing.