NOTICE OF PROPOSED AMENDMENT (NPA) No 10/2004
DRAFT DECISION OF THE EXECUTIVE DIRECTOR OF THE AGENCY,
on certification specifications for large aeroplanes (CS-25)
APU Installation and Fuel Tank Safety

CONTENTS

This Notice of Proposed Amendment is bundling the following original JAA NPAs which have followed and completed the JAA consultation process:

I) JAA NPA 25J-300, Subpart J - Gas Turbine Auxiliary Power Unit Installations

II) JAA NPA 25E-342, Revised Fuel Tank Ignition Prevention Requirements for Large Aeroplanes

This Notice of Proposed Amendment is made up of following parts :

0 GENERAL EXPLANATORY NOTE

0-1 General

The initial issue of CS-25 was based upon JAR-25 at amendment 16. During the transposition of airworthiness JARs into certification specifications the rulemaking activities under the JAA system were not stopped. In order to assure a smooth transition from JAA to EASA the Agency has committed itself to continue as much as possible of the JAA rulemaking activities. Therefore it has included most of the JAA rulemaking activities in the Agency's rulemaking programme for 2004 and planning for 2005-2007.

The purpose of this Notice of Proposed Amendment (NPA) is to propose changes to the certifications specifications for large aeroplanes (CS-25). The reason for this proposal is outlined further below. This measure is included in the Agency's 2004 rulemaking programme.

The NPA has been adapted to the EASA regulatory context by the Agency. It is now submitted for consultation of all interested parties in accordance with Article 5(3) of the EASA rulemaking procedure[1].
The review of comments will be made by the Agency unless the comments are of such nature that they necessitate the establishment of a group.

0-2 Consultation

Because the content of these NPA's was already agreed for adoption in the Joint Aviation Authorities (JAA) system and was the subject of a full worldwide consultation, the transitional arrangements of article 15 of the EASA rulemaking procedure apply. They allow for a shorter consultation period of six weeks instead of the standard three months and also exempt from the requirement to produce a full Regulatory Impact Assessment.

To achieve optimal consultation, the Agency is publishing the draft decision on its internet site in order to reach its widest audience and collect the related comments.

Comments on this proposal may be forwarded *(preferably by e-mail)*, using the attached comment form, to:

By e-mail: NPA@easa.eu.int

By correspondence: **Ms.** Inge van Opzeeland
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Comments should be received by the Agency **before 22/12/2004** and if received after this deadline they might not be treated. Comments may not be considered if the form provided for this purpose is not used.

[1] Decision of the Management Board concerning the procedure to be applied by the Agency for the issuing of opinions, certification specifications and guidance material ("rulemaking procedure"), EASA MB/7/03, 27.6.2003.

0-3 Comment response document

All comments received will be responded to and incorporated in a Comment Response Document (CRD). This will contain a list of all persons and/or organisations that have provided comments. The CRD will be made widely available before the Agency adopts its final decision.

I-A. EXPLANATORY NOTE JAA NPA 25J-300

Originally JAA NPA 25J-300, Gas Turbine Auxiliary Power Unit Installations, December 2002

The text of the JAA NPA 25J-300 was developed by the JAA in the framework of the Harmonisation Work Programme and was sponsored by the Powerplant Study Group (PPSG)

JAA NPA 25J-300 was adopted by the JAAC on 12 September 2003 under a written procedure.

I-B. PROPOSALS TRANSPOSED JAA NPA 25J-300

The following amendments should be included in Decision No. 2003/2/RM of the Executive Director of the Agency of 17 October 2003:

A- To delete CS 25.1522.

B- To remove reference to CS 25.1522 in CS 25.1583(b)(1).

C- To delete in its entirety the current Subpart J.

D- To delete the corresponding AMC (AMC 25A901(b)(2) to AMC 25A1195(b)).

E- To create a new Subpart J .

F- To create AMC 25J901(c)(2), AMC 25J901(c)(4), AMC 25J943, AMC 25J955(a)(4), AMC 25J991, AMC 25J1041, AMC 25J1093(b)(2) and AMC 25J1195(b).

BOOK 1 **CS 25**

SUBPART J - GAS TURBINE AUXILIARY POWER UNIT INSTALLATIONS

GENERAL

CS 25J901 Installation

(a) For the purpose of this subpart, the APU installation includes:

(1) Any engine delivering rotating shaft power, compressed air, or both, which is not intended for direct propulsion of an aeroplane.

(2) Each component that affects the control of the APU.

(3) Each component that affects the safety of the APU.

(b) For the purpose of this subpart,

(1) An essential APU is defined as an APU whose function is required for the dispatch of the aeroplane and/or continued safe flight.

(2) A non-essential APU is defined as an APU whose function is a matter of convenience, either on the ground or in flight, and may be shut down without jeopardising safe aeroplane operation.

(c) For each APU-

(1) The installation must comply with:

(i) The installation instructions provided under CS-APU, and

(ii) The applicable provisions of this subpart for non-essential APUs, or

(iii)The applicable provisions of this subpart for essential APUs.

(2) The components of the installation must be constructed, arranged, and installed so as to ensure their continued safe operation between normal inspections or overhauls. (See AMC 25J901(c)(2).)

(3) The installation must be accessible for necessary inspections and maintenance; and

(4) The major components of the installation must be electrically bonded to the other parts of the aeroplane. (See AMC 25J901(c)(4).)

(d) The APU installation must comply with CS 25.1309, except that the effects of the following need not comply with CS 25.1309(b) (see AMC 25.901(c)):

(i) APU case burn through or rupture; and

(ii) Uncontained APU rotor failure.

CS 25J903 Auxiliary Power Unit

(a) Each APU must meet the appropriate requirements of CS-APU for its intended function:

(1) Essential: Category 1 APU,

(2) Non-essential: Category 1 or Category 2 APU.

(c) Control of APU rotation and shut-down capability.

(1) It shall be possible to shut down the APU from the flight deck in normal and emergency conditions.

(2) Where continued rotation of an APU could jeopardise the safety of the aeroplane, there must be a means for stopping rotation. Each component of the stopping system located in the APU compartment must be at least fire resistant.

(d) For APU installation:

(1) Design precautions must be taken to minimise the hazards to the aeroplane in the event of an APU rotor failure or of a fire originating within the APU which burns through the APU casing. (See AMC 20-128A.)

(2) The systems associated with APU control devices, systems and instrumentation, must be designed to give reasonable assurance that those APU operating limitations that adversely affect turbine rotor structural integrity will not be exceeded in service.

(e) In-flight start capability.

(1) For non-essential APUs that can be started in-flight and all essential APUs-

(i) Means must be provided to start the APU-in flight, and

(ii) An altitude and airspeed envelope must be established and demonstrated for APU in-flight starting.

(2) For essential APUs-

Cold soak must be considered in establishing the envelope of CS 25J903(e)(1)(ii).

CS 25J939 APU operating characteristics

(a) APU operating characteristics must be investigated to determine that no adverse characteristics (such as stall, surge, or flame-out) are present, to a hazardous degree, during normal and emergency operation within the range of operation limitations of the aeroplane and of the APU.

(c) The APU air inlet system may not, as a result of air-flow distortion during normal operation, cause vibration harmful to the APU.

(d) It must be established over the range of operating conditions for which certification is required, that the APU installation vibratory conditions do not exceed the critical frequencies and amplitudes established under CS-APU, section 1, appendix 1, paragraph 6.18.

CS 25J943 Negative acceleration

No hazardous malfunction of an APU or any component or system associated with the APU may occur when the aeroplane is operated at the negative accelerations within the flight envelopes prescribed in CS 25.333. This must be shown for the greatest duration expected for the acceleration. (See AMC 25J943.)

FUEL SYSTEM

CS 25J951 General

(a) Each fuel system must be constructed and arranged to ensure a flow of fuel at a rate and pressure established for proper APU functioning under each likely operating condition, including any manoeuvre for which certification is requested and during which the APU is permitted to be in operation.

(b) For essential APUs-

Each fuel system must be arranged so that any air which is introduced into the system will not result in flameout.

(c) For essential APUs-

Each fuel system for an essential APU must be capable of sustained operation throughout its flow and pressure range with fuel initially saturated with water at 26.7 °C and having 0.10 cm^3 of free water per liter added and cooled to the most critical condition for icing likely to be encountered in operation.

CS 25J952 Fuel system analysis and test

(a) Proper fuel system functioning under all probable operating conditions must be shown by analysis and those tests found necessary by the Agency. Tests, if required, must be made using the aeroplane fuel system or a test article that reproduces the operating characteristics of the portion of the fuel system to be tested.

(b) The likely failure of any heat exchanger using fuel as one of its fluids may not result in a hazardous condition.

CS 25J953 Fuel system independence

Each fuel system must allow the supply of fuel to the APU-

(a) Through a system independent of each part of the system supplying fuel to the main engines; or

(b) From the fuel supply to the main engine if provision is made for a shut-off means to isolate the APU fuel line.

CS 25J955 Fuel flow

(a) Each fuel system must provide at least 100 percent of the fuel flow required by the APU under each intended operating condition and manoeuvre. Compliance must be shown as follows:

(1) Fuel must be delivered at a pressure within the limits specified for the APU.

(2) For essential APUs-

(i) The quantity of fuel in the tank may not exceed the amount established as the unusable fuel supply for that tank under the requirements of CS 25.959 plus that necessary to show compliance with this section.

(ii) Each main pump must be used that is necessary for each operating condition and attitude for which compliance with this section is shown, and the appropriate emergency pump must be substituted for each main pump so used.

(iii) If there is a fuel flowmeter, it must be blocked and the fuel must flow through the meter or its bypass. (See AMC 25J955(a)(4).)

(b) For essential APUs-

If an APU can be supplied with fuel from more than one tank, the fuel system must, in addition to having appropriate manual switching capability, be designed to prevent interruption of fuel flow to that APU, without attention by the flight crew, when any tank supplying fuel to that APU is depleted of usable fuel during normal operation, and any other tank, that normally supplies fuel to that APU, contains usable fuel.

CS 25J961 Fuel system hot weather operation

For essential APUs-

(a) The fuel supply of an APU must perform satisfactorily in hot weather operation. It must be shown that the fuel system from the tank outlet to the APU is pressurised under all intended operations so as to prevent vapour formation. Alternatively, it must be shown that there is no evidence of vapour lock or other malfunctioning during a climb from the altitude of the airport selected by the applicant to the maximum altitude established as an operating limitation under CS 25J1527, with the APU operating at the most critical conditions for vapour formation but not exceeding the maximum essential load conditions. If the fuel supply is dependant on the same fuel pumps or fuel supply as the main engines, the main engines must be operated at maximum continuous power.

(5) The fuel temperature must be at least 43°C at the start of the climb.

(b) The test prescribed in sub-paragraph (a) of this paragraph may be performed in flight or on the ground under closely simulated flight conditions. If a flight test is performed in weather cold enough to interfere with the proper conduct of the test, the fuel tank surfaces, fuel lines, and other fuel system parts subject to cold air must be insulated to simulate, insofar as practicable, flight in hot weather.

CS 25J977 Fuel tank outlet

For essential APUs-

(a) There must be a fuel strainer for the fuel tank outlet or for the booster pump. This strainer must prevent the passage of any object that could restrict fuel flow or damage any fuel system component.

(b) The clear area of each fuel tank outlet strainer must be at least five times the area of the outlet line.

(c) The diameter of each strainer must be at least that of the fuel tank outlet.

(d) Each finger strainer must be accessible for inspection and cleaning.

CS 25J991 Fuel pumps

(See AMC 25J991)

For essential APUs-

(a) Main pumps. Each fuel pump required for proper essential APU operation, or required to meet the fuel system requirements of this subpart (other than those in sub-paragraph (b) of this paragraph), is a main pump. For each main pump, provision must be made to allow the bypass of each positive displacement fuel pump other than a fuel pump approved as part of the APU.

(b) Emergency pumps. There must be emergency pumps or another main pump to feed an essential APU immediately after failure of any main pump (other than a fuel pump approved as part of the APU).

CS 25J993 Fuel system lines and fittings

(a) Each fuel line must be installed and supported to prevent excessive vibration and to withstand loads due to fuel pressure and accelerated flight conditions.

(b) Each fuel line connected to components of the aeroplane between which relative motion could exist must have provisions for flexibility.

(c) Each flexible connection in fuel lines that may be under pressure and subjected to axial loading must use flexible hose assemblies.

(d) Flexible hose must be approved or must be shown to be suitable for the particular application.

(e) No flexible hose that might be adversely affected by exposure to high temperatures may be used where excessive temperatures will exist during operation or after an APU shut-down.

(f) Each fuel line within the fuselage must be designed and installed to allow a reasonable degree of deformation and stretching without leakage.

CS 25J994 Fuel system components

Fuel system components in the APU compartment or in the fuselage must be protected from damage which could result in spillage of enough fuel to constitute a fire hazard as a result of a wheels-up landing on a paved runway.

CS 25J995 Fuel valves

In addition to the requirements of CS 25J1189 for shut-off means, each fuel valve must be supported so that no loads resulting from their operation or from accelerated flight conditions are transmitted to the lines attached to the valve, unless adequate strength margins under all loading conditions are provided in the lines and connections.

CS 25J997 Fuel strainer or filter

For essential APUs-

There must be a fuel strainer or filter between the fuel tank outlet and the inlet of either the fuel metering device or an APU driven positive displacement pump, whichever is nearer the fuel tank outlet. This fuel strainer or filter must-

(a) Be accessible for draining and cleaning and must incorporate a screen or element which is easily removable;

(b) Have a sediment trap and drain except that it need not have a drain if the strainer or filter is easily removable for drain purposes;

(c) Be mounted so that its weight is not supported by the connecting lines or by the inlet or outlet connections of the strainer or filter itself, unless adequate strength margins under all loading conditions are provided in the lines and connections; and

(d) Have the capacity (with respect to operating limitations established for the APU) to ensure that APU fuel system functioning is not impaired, with the fuel contaminated to a degree (with respect to particle size and density) that is greater than that established for the APU in CS-APU 250.

OIL SYSTEM

CS 25J1011 Oil System General

(a) Each APU must have an independent oil system that can supply it with an appropriate quantity of oil at a temperature not above that safe for continuous operation.

(b) The usable oil capacity may not be less than the product of the endurance of the aeroplane and the maximum allowable oil consumption of the APU plus a suitable margin to ensure system circulation.

CS 25J1017 Oil lines and fittings

(a) Each oil line must meet the requirements of CS 25J993 and each oil line and fitting in any designated fire zone must meet the requirements of CS 25J1183.

(b) Breather lines must be arranged so that-

(1) Condensed water vapour that might freeze and obstruct the line cannot accumulate at any point;

(2) The breather discharge does not constitute a fire hazard;

(3) The breather does not discharge into the APU air intake system.

CS 25J1019 Oil filter

Where there is a filter in the APU lubrication system through which all the oil flows, it must be constructed and installed so that oil may flow at an acceptable rate through the rest of the system with the filter element completely blocked. An impending filter by-pass indication is required.

CS 25J1021 Oil system drains

A drain (or drains) must be provided to allow safe drainage of the oil system. Each drain must-

(a) Be accessible; and

(b) Have manual or automatic means for positive locking in the closed position.

CS 25J1023 Oil radiators

(a) Each oil radiator must be able to withstand, without failure, any vibration, inertia, and oil pressure load to which it would be subjected in operation.

CS 25J1025 Oil valves

(a) Each oil shut-off must meet the requirements of CS 25J1189.

(b) Each oil valve must have positive stops or suitable index provisions in the "on" and "off" positions and must be supported so that no loads resulting from its operation or from accelerated flight conditions are transmitted to the lines attached to the valve, unless adequate strength margins under all loading conditions are provided in the lines and connections.

COOLING

CS 25J1041 General

The APU cooling provisions must be able to maintain the temperatures of APU components and fluids within the temperature limits established for these components and fluids, under critical ground and flight operating conditions, and after normal APU shutdown. (See AMC 25J1041.)

CS 25J1043 Cooling tests

(a) General. Compliance with CS 25J1041 must be shown by tests, under critical conditions. For these tests, the following apply:

(1) If the tests are conducted under conditions deviating from the maximum ambient atmospheric temperature, the recorded APU temperatures must be corrected under sub-paragraph (c) of this paragraph.

(2) No corrected temperatures determined under sub-paragraph (a)(1) of this paragraph may exceed established limits.

(b) Maximum ambient atmospheric temperature. A maximum ambient atmospheric temperature corresponding to sea level conditions must be established. The temperature lapse rate is 2.0°C per 300 meter of altitude above sea level until a temperature of -56.5°C is reached, above which altitude, the temperature is considered constant at -56.5°C.

(c) Correction factor. Unless a more rational correction applies, temperatures of APU fluids and components for which temperature limits are established, must be corrected by adding to them the difference between the maximum ambient atmospheric temperature and the temperature of the ambient air at the time of the first occurrence of the maximum component or fluid temperature recorded during the cooling test.

CS 25J1045 Cooling test procedures

(a) Compliance with CS 25J1041 must be shown for the critical conditions that correspond to the applicable performance requirements. The cooling tests must be conducted with the aeroplane in the configuration, and operating under the conditions that are critical relative to cooling. For the cooling tests, a temperature is 'stabilised' when its rate of change is less than 1°C per minute.

(b) Temperatures must be stabilised prior to entry into each critical condition being investigated, unless the entry condition normally is not one during which component and APU fluid temperatures would stabilise (in which case, operation through the full entry condition must be conducted before entry into the critical condition being investigated in order to allow temperatures to reach their natural levels at the time of entry).

(c) Cooling tests for each critical condition must be continued until-

(1) The component and APU fluid temperatures stabilise;

(2) The stage of flight is completed; or

(3) An operating limitation is reached.

AIR INTAKE AND BLEED AIR DUCT SYSTEMS

CS 25J1091 Air intake

The air intake system for the APU-

(a) Must supply the air required by the APU under each operating condition for which certification is requested,

(b) May not draw air from within the APU compartment or other compartments unless the inlet is isolated from the APU accessories and power section by a firewall,

(c) Must have means to prevent hazardous quantities of fuel leakage or overflow from drains, vents, or other components of flammable fluid systems from entering,

(d) Must be designed to prevent water or slush on the runway, taxiway, or other airport operating surface from being directed into the air intake system in hazardous quantities,

(e) Must be located or protected so as to minimise the ingestion of foreign matter during takeoff, landing, and taxiing.

CS 25J1093 Air intake system icing protection

(a) Each non-essential APU air intake system, including any screen if used, which does not comply with CS 25J1093(b) will be restricted to use in non-icing conditions, unless it can be shown that the APU complete with air intake system, if subjected to icing conditions, will not affect the safe operation of the aeroplane.

(b) For essential APUs-

Each essential APU air intake system, including screen if used, must enable the APU to operate over the range of conditions for which certification is required without adverse effect or serious loss of power (see AMC 25J1093(b)(2)):

(1) Under the icing conditions specified in Appendix C; and

(2) In falling and blowing snow within the limitations established for the aeroplane for such operations.

CS 25J1103 Air intake system ducts

(a) Each air intake system duct must be-

(1) Drained to prevent accumulation of hazardous quantities of flammable fluid and moisture in the ground attitude. The drain(s) must not discharge in locations that might cause a fire hazard; and

(2) Constructed of materials that will not absorb or trap sufficient quantities of flammable fluids such as to create a fire hazard.

(b) Each duct must be-

(1) Designed to prevent air intake system failures resulting from reverse flow, APU surging, or inlet door closure; and

(2) Fireproof within the APU compartment and for a sufficient distance upstream of the APU compartment to prevent hot gases reverse flow from burning through the APU air intake system ducts and entering any other compartment or area of the aeroplane in which a hazard would be created resulting from the entry of hot gases.
The materials used to form the remainder of the air intake system duct and plenum chamber of the APU must be capable of resisting the maximum heat conditions likely to occur.

(c) Each duct connected to components between which relative motion could exist must have means for flexibility.

CS 25J1106 Bleed air duct systems

(a) For APU bleed air duct systems, no hazard may result if a duct failure occurs at any point between the air duct source and the aeroplane unit served by the bleed air.

(b) Each duct connected to components between which relative motion could exist must have a means for flexibility.

(c) Where the airflow delivery from the APU and main engine is delivered to a common manifold system, precautions must be taken to minimise the possibility of a hazardous condition due to reverse airflow through the APU resulting from malfunctions of any component in the system.

EXHAUST SYSTEM

CS 25J1121 General

(a) Each exhaust system must ensure safe disposal of exhaust gases without fire hazard or carbon monoxide contamination in any personnel compartment. For test purposes, any acceptable carbon monoxide detection method may be used to show the absence of carbon monoxide.

(b) Each exhaust system part with a surface hot enough to ignite flammable fluids or vapours must be located or shielded so that leakage from any system carrying flammable fluids or vapours will not result in a fire caused by impingement of the fluids or vapours on any part of the exhaust system including shields for the exhaust system.

(c) Each component that hot exhaust gases could strike, or that could be subjected to high temperatures from exhaust system parts, must be fireproof. All exhaust system components must be separated by fireproof shields from adjacent parts of the aeroplane that are outside the APU compartment.

(d) No exhaust gases may discharge so as to cause a fire hazard with respect to any flammable fluid vent or drain.

(f) Each exhaust system component must be ventilated to prevent points of excessively high temperature.

(g) Each exhaust shroud must be ventilated or insulated to avoid, during normal operation, a temperature high enough to ignite any flammable fluids or vapours external to the shroud.

CS 25J1123 Exhaust piping

(a) Exhaust piping must be heat and corrosion resistant, and must have provisions to prevent failure due to expansion by operating temperatures.

(b) Piping must be supported to withstand any vibration and inertia loads to which it would be subjected in operation; and

(c) Piping connected to components between which relative motion could exist must have means for flexibility.

APU CONTROLS AND ACCESSORIES

CS 25J1141 APU controls

(a) Means must be provided on the flight deck for starting, stopping, and emergency shutdown of each installed APU. Each control must-

(1) Be located, arranged, and designed under CS 25.777(a)(b)(c)(d) and marked under CS 25.1555(a); and

(2) Be located so that it cannot be inadvertently operated by persons entering, leaving, or moving normally on the flight deck; and

(3) Be able to maintain any set position without constant attention by flight crew members and without creep due to control loads or vibration; and

(4) Have sufficient strength and rigidity to withstand operating loads without failure and without excessive deflection; and

(5) For flexible controls, be approved or must be shown to be suitable for the particular application.

(b) APU valve controls located in the flight deck must have-

(1) For manual valves, positive stops or, in the case of fuel valves, suitable index provisions in the open and closed positions,

(2) In the case of valves controlled from the flight deck other than by mechanical means, where the correct functioning of the valve is essential for the safe operation of the aeroplane, a valve position indicator which senses directly that the valve has attained the position selected must be provided, unless other indications in the flight deck give the flight crew a clear indication that the valve has moved to the selected position. A continuous indicator need not be provided.

(c) For unattended operation, the APU installation must:

(1) Provide means to automatically shutdown the APU for the following conditions:

(i) Exceedence of any APU parameter limit or existence of a detectable hazardous APU operating condition; and

(ii) Bleed air duct failure between the APU and aeroplane unit served by the bleed air, unless it can be shown that no hazard exists to the aeroplane.

(2) Provide means to automatically shut off flammable fluids per CS 25J1189 in case of fire in the APU compartment.

(d) APU controls located elsewhere on the aeroplane, which are in addition to the flight deck controls, must meet the following requirements:

(1) Each control must be located so that it cannot be inadvertently operated by persons entering, leaving, or moving normally in the area of the control; and

(2) Each control must be able to maintain any set position without creep due to control loads, vibration, or other external forces resulting from the location.

(e) The portion of each APU control located in a designated fire zone that is required to be operated in the event of a fire must be at least fire resistant.

CS 25J1163 APU accessories

(a) APU mounted accessories must be approved for installation on the APU concerned and use the provisions of the APU for mounting.

(b) Electrical equipment subject to arcing or sparking must be installed to minimise the probability of contact with any flammable fluids or vapours that might be present in a free state.

(c) For essential APUs-

If continued rotation of a failed aeroplane accessory driven by the APU affects the safe operation of the aeroplane, there must be means to prevent rotation without interfering with the continued operation of the APU.

CS 25J1165 APU ignition systems

Each APU ignition system must be independent of any electrical circuit except those used for assisting, controlling, or analysing the operation of that system.

APU FIRE PROTECTION

CS 25J1181 Designated fire zone

(a) Any APU compartment is a designated fire zone.

(b) Each designated fire zone must meet the requirements of CS 25J1185 through CS 25J1203.

CS 25J1183 Lines, fittings and components

(a) Except as provided in sub-paragraph (b) of this paragraph, each line, fitting, and other component carrying flammable fluid in any area subject to APU fire conditions, and each component which conveys or contains flammable fluid in a designated fire zone must be fire resistant, except that flammable fluid tanks and supports in a designated fire zone must be fireproof or be enclosed by a fireproof shield unless damage by fire to any non-fireproof part will not cause leakage or spillage of flammable fluid. Components must be shielded or located to safeguard against the ignition of leaking flammable fluid.

(b) Sub-paragraph (a) of this paragraph does not apply to-

(1) Lines and fittings already approved as part of an APU, and

(2) Vent and drain lines, and their fittings, whose failure will not result in, or add to, a fire hazard.

(c) All components, including ducts, within a designated fire zone which, if damaged by fire could result in fire spreading to other regions of the aeroplane, must be fireproof. Those components within a designated fire zone, which could cause unintentional operation of, or inability to operate essential services or equipment, must be fireproof.

CS 25J1185 Flammable fluids

(a) No tank or reservoir that is a part of a system containing flammable fluids or gases may be in a designated fire zone unless the fluid contained, the design of the system, the materials used in the tank, the shut-off means, and all connections, lines, and controls provide a degree of safety equal to that which would exist if the tank or reservoir were outside such a zone.

(b) There must be at least 12,7 mm of clear airspace between each tank or reservoir and each firewall or shroud isolating a designated fire zone.

(c) Absorbent materials close to flammable fluid system components that might leak must be covered or treated to prevent the absorption of hazardous quantities of fluids.

CS 25J1187 Drainage and ventilation of fire zones

(a) There must be complete drainage of each part of each designated fire zone to minimise the hazards resulting from failure or malfunctioning of any component containing flammable fluids. The drainage means must be-

(1) Effective under conditions expected to prevail when drainage is needed; and

(2) Arranged so that no discharged fluid will cause an additional fire hazard.

(b) Each designated fire zone must be ventilated to prevent the accumulation of flammable vapours.

(c) No ventilation opening may be where it would allow the entry of flammable fluids, vapours, or flame from other zones.

(d) Each ventilation means must be arranged so that no discharged vapours will cause an additional fire hazard.

(e) Unless the extinguishing agent capacity and rate of discharge are based on maximum air flow through a zone, there must be means to allow the crew to shut off sources of forced ventilation to any fire zone.

CS 25J1189 Shut-off means

(a) Each APU compartment specified in CS 25J1181(a) must have a means to shut-off or otherwise prevent hazardous quantities of flammable fluids, from flowing into, within, or through any designated fire zone, except that shut-off means are not required for-

(1) Lines, fittings and components forming an integral part of an APU; and

(2) Oil systems for APU installations in which all external components of the oil system, including the oil tanks, are fireproof.

(b) The closing of any fuel shut-off valve for any APU may not make fuel unavailable to the main engines.

(c) Operation of any shut-off may not interfere with the later emergency operation of other equipment.

(d) Each flammable fluid shut-off means and control must be fireproof or must be located and protected so that any fire in a fire zone will not affect its operation.

(e) No hazardous quantity of flammable fluid may drain into any designated fire zone after shut-off.

(f) There must be means to guard against inadvertent operation of the shut-off means and to make it possible for the crew to reopen the shut-off means in flight after it has been closed.

(g) Each tank to APU shut-off valve must be located so that the operation of the valve will not be affected by the APU mount structural failure.

(h) Each shut-off valve must have a means to relieve excessive pressure accumulation unless a means for pressure relief is otherwise provided in the system.

CS 25J1191 Firewalls

(a) Each APU must be isolated from the rest of the aeroplane by firewalls, shrouds, or equivalent means.

(b) Each firewall and shroud must be-

(1) Fireproof;

(2) Constructed so that no hazardous quantity of air, fluid, or flame can pass from the compartment to other parts of the aeroplane;

(3) Constructed so that each opening is sealed with close fitting fireproof grommets, bushings, or firewall fittings; and

(4) Protected against corrosion.

CS 25J1193 APU compartment

(a) Each compartment must be constructed and supported so that it can resist any vibration, inertia, and air load to which it may be subjected in operation.

(b) Each compartment must meet the drainage and ventilation requirements of CS 25J1187.

(d) Each part of the compartment subject to high temperatures due to its nearness to exhaust system parts or exhaust gas impingement must be fireproof.

(e) Each aeroplane must-

(1) Be designed and constructed so that no fire originating in any APU fire zone can enter, either through openings or by burning through external skin, any other zone or region where it would create additional hazards,

(2) Meet sub-paragraph (e)(1) of this paragraph with the landing gear retracted (if applicable), and

(3) Have fireproof skin in areas subject to flame if a fire starts in the APU compartment.

CS 25J1195 Fire extinguisher systems

(a) There must be a fire extinguisher system serving the APU compartment.

(b) The fire extinguishing system, the quantity of the extinguishing agent, the rate of discharge, and the discharge distribution must be adequate to extinguish fires. An individual 'one shot' system is acceptable. (See AMC 25J1195(b).)

(c) The fire-extinguishing system for an APU compartment must be able to simultaneously protect each zone of the APU compartment for which protection is provided.

CS 25J1197 Fire extinguishing agents

(a) Fire extinguishing agents must-

(1) Be capable of extinguishing flames emanating from any burning of fluids or other combustible materials in the area protected by the fire extinguishing system; and

(2) Have thermal stability over the temperature range likely to be experienced in the compartment in which they are stored.

(b) If any toxic extinguishing agent is used, provisions must be made to prevent harmful concentrations of fluid or fluid vapours (from leakage during normal operation of the aeroplane or as a result of discharging the fire extinguisher on the ground or in flight) from entering any personnel compartment, even though a defect may exist in the extinguishing system.

CS 25J1199 Extinguishing agent containers

(a) Each extinguishing agent container must have a pressure relief to prevent bursting of the container by excessive internal pressures.

(b) The discharge end of each discharge line from a pressure relief connection must be located so that discharge of the fire extinguishant agent would not damage the aeroplane. The line must be located or protected to prevent clogging caused by ice or other foreign matter.

(c) There must be a means for each fire extinguishing agent container to indicate that the container has discharged or that the charging pressure is below the established minimum necessary for proper functioning.

(d) The temperature of each container must be maintained, under intended operating conditions, to prevent the pressure in the container from-

(1) Falling below that necessary to provide an adequate rate of discharge; or

(2) Rising high enough to cause premature discharge.

(e) If a pyrotechnic capsule is used to discharge the extinguishing agent, each container must be installed so that temperature conditions will not cause hazardous deterioration of the pyrotechnic capsule.

CS 25J1201 Fire extinguishing system materials

(a) No material in any fire extinguishing system may react chemically with any extinguishing agent so as to create a hazard.

(b) Each system component in an APU compartment must be fireproof.

CS 25J1203 Fire-detector system

(a) There must be approved, quick acting fire or overheat detectors in each APU compartment in numbers and locations ensuring prompt detection of fire.

(b) Each fire detector system must be constructed and installed so that-

(1) It will withstand the vibration, inertia, and other loads to which it may be subjected in operation;

(2) There is a means to warn the crew in the event that the sensor or associated wiring within a designated fire zone is severed at one point, unless the system continues to function as a satisfactory detection system after the severing; and

(3) There is a means to warn the crew in the event of a short circuit in the sensor or associated wiring within a designated fire zone, unless the system continues to function as a satisfactory detection system after the short circuit.

(c) No fire or overheat detector may be affected by any oil, water, other fluids, or fumes that might be present.

(d) There must be means to allow the crew to check, in flight, the functioning of each fire or overheat detector electric circuit.

(e) Wiring and other components of each fire or overheat detector system in a fire zone must be at least fire-resistant.

(f) No fire or overheat detector system component for any fire zone may pass through another fire zone, unless-

(1) It is protected against the possibility of false warnings resulting from fires in zones through which it passes; or

(2) Each zone involved is simultaneously protected by the same detector and extinguishing system.

(g) Each fire detector system must be constructed so that when it is in the configuration for installation it will not exceed the alarm activation time approved for the detectors using the response time criteria specified in ETSO-2C11e or an acceptable equivalent, for the detector.

CS 25J1207 Compliance

Unless otherwise specified, compliance with the requirements of CS 25J1181 through CS 25J1203 must be shown by a full scale test or by one or more of the following methods:

(a) Tests of similar APU installations.

(b) Tests of components.

(c) Service experience of aircraft with similar APU installations.

(d) Analysis unless tests are specifically required.

GENERAL

CS 25J1305 APU instruments

(a) The following instruments are required for all installation:

(1) A fire warning indicator.

(2) An indication than an APU auto-shutdown has occurred.

(3) Any other instrumentation necessary to assist the flight crew in-

(i) Preventing the exceedence of established APU limits, and

(ii) Maintaining continued safe operation of the APU.

(4) Instrumentation per subparagraph (3) need not be provided if automatic features of the APU and its installation provide a degree of safety equal to having the parameter displayed directly.

(b) For essential APUs-

In addition to the items required by CS 25J1305(a), the following indicators are required for an essential APU installation :

(1) An indicator to indicate the functioning of the ice protection system, if such a system is installed; and

(2) An indicator to indicate the proper functioning of any heater used to prevent ice clogging of fuel system components.

CS 25J1337 APU instruments

(d) There must be a stick gauge or equivalent means to indicate the quantity of oil in each tank.

OPERATING LIMITATIONS

CS 25J1501 General

(b) The operating limitations and other information necessary for safe operation must be made available to the crew members as prescribed in CS 25J1549, 25J1551, and 25J1583.

CS 25J1521 APU limitations

The APU limitations must be established so that they do not exceed the corresponding approved limits for the APU and its systems. The APU limitations, including categories of operation, must be specified as operating limitations for the aeroplane.

CS 25J1527 Ambient air temperature and operating altitude

The extremes of the ambient air temperature and operating altitude for which operation is allowed, as limited by flight, structural, APU installation, functional, or equipment characteristics, must be established.

MARKINGS AND PLACARDS

CS 25J1549 APU instruments

For each APU instrument either a placard or colour markings or an acceptable combination must be provided to convey information on the maximum and (where applicable) minimum operating limits. Colour coding must comply with the following:-

(a) Each maximum and, if applicable, minimum safe operating limit must be marked with a red radial or a red line;

(b) Each normal operating range must be marked with a green arc or green line, not extending beyond the maximum and minimum safe limits;

(c) Each precautionary operating range must be marked with a yellow arc or a yellow line; and

(d) Each APU speed range that is restricted because of excessive vibration stresses must be marked with red arcs or red lines.

CS 25J1551 Oil quantity indicator

Each oil quantity indicator must be marked with enough increments to indicate readily and accurately the quantity of oil.

CS 25J1557 Miscellaneous markings and placards

(b) APU fluid filler openings

(2) Oil filler openings must be marked at or near the filler cover with the word "oil".

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CS 25J1583 Operating limitations

APU limitations established under CS 25J1521 and information to explain the instrument markings provided under CS 25J1549 and CS 25J1551 must be furnished.

AMC - SUBPART J

AMC 25J901(c)(2)
Assembly of Components (Auxiliary Power Units) (Interpretative Material)

The objectives of CS 25.671(b) should be satisfied with respect to APU systems, where the safety of the aeroplane could otherwise be jeopardised.

AMC 25J901(c)(4)
Electrical Bonding (Auxiliary Power Units) (Interpretative Material)

Where the APU is not in direct electrical contact with its mounting the engine should be electrically connected to the main earth system by at least two removable primary conductors, one on each side of the APU.

AMC 25J943
APU Operating Characteristics (Auxiliary Power Units) (Interpretative Material)

1 Compliance with CS 25J943 should be shown by design analysis and flight tests. The flight tests should include manoeuvre in which less than zero 'g' occurs for one continuous period of at least 5 seconds and a further manoeuvre with two periods of less than zero 'g' with a total time for these two periods of at least 5 seconds.

2 In the case of non-essential APUs, inadvertent shut-down due to negative accelerations is acceptable.

AMC 25J955(a)(4)
Fuel Flow (Interpretative Material)

The word "blocked" should be interpreted to mean "with the moving parts fixed in the position for maximum pressure drop".

AMC 25J991
Fuel Pumps (Auxiliary Power Units) (Interpretative Material)

If the fuel supply to the APU is taken from the fuel supply to the main engine, no separate pumps need be provided for the APU.

AMC 25J1041
General (Auxiliary Power Units) (Interpretative Material)

The need for additional tests, if any, in hot climatic conditions should take account of any tests made by the APU constructor to establish APU performance and functioning characteristics and of satisfactory operating experience of similar power units installed in other types of aeroplane.

The maximum climatic conditions for which compliance will be established should be declared and this should not be less severe than the ICAO Intercontinental Maximum Standard Climate 37·8ºC at sea-level). If the tests are conducted under conditions which deviate from the maximum declared ambient temperature, the maximum temperature deviation should not normally exceed 13·88ºC.

AMC 25J1093(b)(2)
Essential APU Air Intakes (Auxiliary Power Units) (Acceptable Means of Compliance and Interpretative Material)

1 *General*. Two ways of showing compliance with CS 25J1093(b)(2) are given.

1.1 *Method 1*. Method 1 is an arbitrary empirical method based on United Kingdom and French practice. This method is acceptable to all participating countries.

1.2 *Method 2*. Method 2 is a general approach based on US practice in applying FAR Part 25, Appendix C. If this method is used, each application will have to be evaluated on its merits.

2 *Method 1 (Acceptable Means of Compliance)*

2.1 In establishing compliance with the requirements of CS 25J1093(b)(2), reference should be made to AMC 25.1419, paragraph 1.

2.2 The intake may be tested with the APU in accordance with the requirements of CS-APU 510 and the Advisory Material for the testing of APUs in Icing Conditions.

2.3 When the intake is assessed separately it should be shown that the effects of intake icing would not invalidate the icing tests of CS-APU. Factors to be considered in such evaluation are -

a. Distortion of the airflow and partial blockage of the intake.

b. The shedding into the APU of intake ice of a size greater than the APU is known to be able to ingest.

c. The icing of any APU sensing devices, other subsidiary intakes or equipment contained within the intake.

d. The time required to bring the protective system into full operation.

2.4 *Tests in Ice-forming Conditions*. An acceptable method of showing compliance with the requirements of CS 25J1093(b)(2), including Appendix C, is given in this paragraph.

2.4.1 When the tests are conducted in non-altitude conditions, the system power supply and the external aero-dynamic and atmospheric conditions should be so modified as to represent the required altitude conditions as closely as possible. The altitudes to be represented should be as indicated in Table 1 for simulated tests, or that appropriate to the desired temperature in flight tests, except that the test altitude need not exceed any limitations proposed for approval. The appropriate intake incidences or the most critical incidence, should be simulated.

2.4.2 Two tests (which may be separated or combined) should be conducted at each temperature condition of Table 1, at or near the indicated altitude -

a. 30 minutes in the conditions of Table 1 column (a) appropriate to the temperature.

b. Three repetitions of 5 km in the conditions of Table 1, column (b), appropriate to the temperature followed by 5 km in clear air.

TABLE 1

Ambient air temperature	Altitude	Liquid water content (g/m^3)		Mean effective droplet diameter (µm)
	(m)	(a)	(b)	
-10 -20 -30	5200 6100 7600	0.6 0.3 0.2	2.2 1.7 1.0	20

2.4.3 At the conclusion of each of the tests of 2.4.2 the ice accretion should be such as not to adversely affect the subsequent running and functioning of the APU.

2.4.4 If the APU intake contains features or devices which could be affected by freezing fog conditions then in addition to the above tests of 2.4.2 a separate test on these parts or devices should be conducted for a duration of 30 minutes with the heat supply to the tested parts as would be available with the APU set to the minimum ground idle conditions approved for use in icing in an atmosphere of -2ºC and a liquid water concentration of 0·3 g/m3. The mean effective droplet size for the test should be 20µm. At the end of the period the ice accretion on the tested part should not prevent its proper functioning nor should the ice be of such size as to hazard the APU if shed.

3 *Method 2 (Interpretative Material)*

3.1 In establishing compliance with the requirements of CS 25J1093(b)(2), reference should be made to CS 25.1419 and AMC 25.1419.

3.2 The intake may be tested with the APU in accordance with a programme of tests which results from an analysis of the icing conditions and the APU conditions appropriate to the installation.

3.3 When the intake is assessed separately it should be shown that the effects of intake icing would not invalidate any APU certification tests. Factors to be considered in such evaluation are -

a. Distortion of the airflow and partial blockage of the intake.

b. The shedding into the APU of intake ice of a size greater than the APU is known to be able to ingest.

c. The icing of any APU sensing devices, other subsidiary intakes or equipment contained within the intake.

d. The time required to bring the protective system into full operation.

3.4 When tests are conducted in non-altitude conditions, the system power supply and the external aerodynamic and atmospheric conditions should be so modified as to represent the altitude condition as closely as possible. The appropriate intake incidences or the most critical incidence, should be simulated.

3.5 Following the analysis required in CS 25.1419(b), which will determine the critical icing conditions within the envelope of icing conditions defined by Appendix C Figures 1 to 3 and Appendix C Figures 4 to 6, tests should be conducted at such conditions as are required to demonstrate the adequacy of the design points.

3.6 At the conclusion of each of the tests the ice accretion should be such as not to adversely affect the subsequent running and functioning of the APU.

3.7 If the APU intake contains features or devices which could be affected by freezing fog conditions then a separate assessment for these parts should be conducted assuming a duration of 30 minutes and an atmosphere of -2ºC and a liquid water concentration of 0·3 g/m3, with the heat supply to the part as would be available with the APU set to the minimum ground idle conditions approved for use in icing. The mean effective droplet size should be 20µm. At the end of the period the ice accretion on the part should not prevent its proper functioning, nor should the ice be of such size as to hazard the engine if shed.

AMC 25J1195(b)
Fire Extinguisher Systems (Auxiliary Power Units) (Interpretative Material and Acceptable Means of Compliance)

Acceptable methods to establish the adequacy of the fire extinguisher system are laid down in FAA Advisory Circular 20 – 100 dated 21 september 1977.

I-C. ORIGINAL JAA NPA 25J-300 PROPOSALS JUSTIFICATION

1 Summary

This NPA proposes to revise subpart J "Gas Turbine Auxiliary Power Units Installations" of the Joint Aviation Requirements for Large Aeroplanes (JAR-25) by incorporating changes developed in co-operation with the US Federal Aviation Administration (FAA) and the Aviation Rulemaking Advisory Committee (ARAC). These proposals are intended to achieve common requirements and language between the JAR and FAR requirements and also make some of the requirements more rational, while maintaining at least the level of safety provided by the current requirements.

2 Background

The manufacturing, marketing and certification of large aeroplanes is increasingly an international endeavour. In order for European manufacturers to export aeroplanes to other countries, the aeroplane must be designed to comply, not only with the European airworthiness requirements for large aeroplanes (JAR-25), but also with the airworthiness requirements of the countries to which the aeroplane is to be exported.
JAR-25 is developed in a format similar to FAR 25. Many other countries have airworthiness codes that are aligned closely to JAR-25 or to FAR 25, or they use these codes directly for their own certification purposes.
Although JAR-25 is very similar to FAR 25, there are differences in methodologies and criteria that often result in the need to address the same design objective with more than one kind of analysis or test in order to satisfy both JAR and FAR 25. These differences result in additional costs to the large aeroplane manufacturers and additional costs to the JAA and foreign authorities that must continue to monitor compliance with a variety of different airworthiness codes.

In 1988, the JAA, in co-operation with the FAA and other organisations representing the European and U.S. aerospace industries, began a process to harmonise the airworthiness requirements of the European authorities with the airworthiness requirements of the United States. The objective was to achieve common requirements for the certification of large aeroplanes without a substantive change in the level of safety provided by the requirements. Other airworthiness authorities such as Transport Canada have also participated in this process.

In 1992, the harmonisation effort was tasked by the FAA to the Aviation Rulemaking Advisory Committee (ARAC) on the US side.

In co-operation and conjunction with ARAC, a working group comprised of specialists from both industry and aviation regulatory authorities from Europe, the United States, and Canada was established to work on the powerplant installation requirements of Subpart E of JAR/FAR 25, "Powerplant". This group is the Powerplant Installation Harmonization Working Group (PPIHWG).

A dedicated Task Group of the PowerPlant Harmonization Working Group was set up to deal with the APU installations requirements.

This notice contains the proposals made by this APU Task Group, necessary to achieve harmonisation for the gas turbine auxiliary power unit installations design and analysis requirements of JAR/FAR 25, contained currently in subpart J of JAR-25.

It is worth noting that since FAR 25 does not feature sections 2 and 3, as found in JAR-25, no attempts were made to change the content of ACJs related to subpart J requirements. Therefore, very few changes were made in section 2.

3 Discussion of the Proposals

Since the introduction of auxiliary power units (APUs) into transport category commercial aircraft, FAR part 25 powerplant installation requirements have been applied to both APUs and main engines. Application of the engine installation requirements to the APU installation has resulted in inconsistent interpretations relative to which part 25 requirements apply only to engines and which requirements apply to both engines and APUs. Joint Aviation Authorities (JAA), when developing JAR-25, have clearly defined the European APU installation requirements in subpart J of JAR-25. Thus, the objective of this proposed amendment is to revise JAR-25 subpart J APU installation requirements and to minimise differences between the FAR part 25 and the JAR-25 subpart J APU installation requirements. The FAA intend to publish a Notice of Proposed Rule Making (NPRM), also developed by the PowerPlant Installation Harmonization Working Group, to introduce appendix K of FAR 25 as necessary to ensure harmonisation for all of the APU installation requirements.

When FAR Part 25 was originally promulgated, APUs were not common in transport category aeroplanes. Since that time, APUs have become widely utilised in these aircraft. While subsequent amendments to the part 25 powerplant regulations have attempted to specifically address some of the APU requirements, they have not always been all-encompassing nor have they always kept current with advances in APU technology.
JAR-25 subpart J has proved to be a much more convenient set of requirements to address APU installations, but for various reasons this subpart was not regularly updated to follow the technological changes. Advances in APU technology include electronic control systems which allow unattended APU operation, minimal monitoring by the flight crew during APU operation inflight, and automatic shutdown features to minimise the potential for APU parameter limit exceedance events. In addition, electronic control of functions previously handled by hydromechanical hardware has become common. Aircraft interface with the APU control system has also evolved with advances in APU and aircraft technologies such as the dark cockpit concept. This situation, with some requirements becoming obsolete, has resulted in an increased number of Certification Review Items or equivalent level of safety findings. In order to address these issues, several of the proposed APU installation requirements differ slightly from the current subpart J requirements in that they have been updated to reflect existing APU and aeroplane technology.

Prior to installation on an aeroplane, all APUs are presently shown to comply with the requirements of JAR-APU or the corresponding American equivalent Technical Standard Order (TSO) C77a. When complying with JAR-APU, the APU manufacturer chooses whether to qualify the unit as capable of providing an "essential" (Category 1) or "non-essential" (Category 2) function when installed on an aeroplane. Upon installation in an aeroplane, the APU’s function on the aeroplane is again evaluated during part 25 certification and categorised accordingly. Presently, JAR-25 subpart J APU installation requirements do not clearly define an essential and non-essential APU installation. This has resulted in misunderstanding and inconsistent interpretations of the applicable regulations for each category of APU installation. The proposed revised subpart J clearly defines the various APU installation categories.

For JAR-25, the harmonisation exercise was therefore a good opportunity to review the requirements, and several mistakes have been corrected (see JAR 25A1183(c)), and several NPA introduced for main engines determined relevant to APU installation were introduced into the new subpart J. In addition, it is worth noting JAR-25 subpart J was not updated on a regular basis for changes introduced in subpart E, when it should have been (for instance, NPA 25 E-262 deleting JAR 25.901(e) might have been transposed to JAR 25A901(d)).

The current subpart J features two parts, part A being applicable to all APU installations and part B giving additional requirements for essential installations. However, the APU Task Group came to the conclusion that this could prove confusing under some circumstances, and is proposing to mix both part A and part B, by making clear which requirements are requested for essential installation only. This is supported by the limited number of requirements applicable only to essential installations.

The proposed rule changes associated with this notice are basically a new subpart J. Since part A and B were deleted, subpart J requirements have been referenced as 25JXXX, previously referenced as 25AXXX or 25BXXX, simply to avoid confusion with main engine installation requirements 25.XXX.
Some changes are made to other subparts, mainly deleting requirements now included in subpart J.

It should be noted this NPA is related to several other NPAs :
NPA 25EXXX 901(c) / 1309 analysis on powerplant installation.
NPA 25E/J-287 "Engine and APU rotor failure". (This NPA has now been introduced by JAR-25, Change 15 as AMJ 20-128A)

The justification for the changed requirements is presented in the following table. This table also includes the rationale for changes in section 2 or in section 1 for requirements outside of subpart J. Rationale for such changes are given in front of the corresponding subpart J requirements.

JUSTIFICATIONS FOR THE PROPOSED HARMONISED APU INSTALLATION REQUIREMENTS

SUBPART J - GAS TURBINE AUXILIARY POWER UNIT INSTALLATIONS

Proposed text	Justification
GENERAL **JAR 25J901 Installation** (a) For the purpose of this subpart, the APU includes: (1) Any engine delivering rotating shaft power, compressed air, or both, which is not intended for direct propulsion of an aeroplane. (2) Each component that affects the control of the APU. (3) Each component that affects the safety of the APU and the APU installation.	Justification : (a) definition of APU Installation introduced.
(b) For the purpose of this subpart, (1) An essential APU is defined as an APU whose function is required for the dispatch of the aeroplane and/or continued safe flight. (2) A non-essential APU is defined as an APU whose function is a matter of convenience, either on the ground or in flight, and may be	(b) defines the terms 'essential' and 'non-essential' function to be consistent with current JAR-APU qualification levels. The best location of those definitions has been determined to be JAR-25 since they are depending entirely upon the aircraft design. JAR-1 needs to be revised accordingly

shut down without jeopardising safe aeroplane operation.	
(c) For each APU-	
(1) The installation must comply with: (i) The installation instructions provided under JAR-APU, and (ii) The applicable provisions of this subpart for non-essential APUs, or (iii)The applicable provisions of this subpart for essential APUs.	(c)(1) similar to current JAR 25A901(b), with modified wording to take into account new subpart J organisation (combination of part A part B).
(2) The components of the installation must be constructed, arranged, and installed so as to ensure their continued safe operation between normal inspections or overhauls. (See ACJ 25J901(c)(2).)	(c)(2) - (c)(4) similar to 25A901(b)(2) - (b)(4)
(3) The installation must be accessible for necessary inspections and maintenance; and	
(4) The major components of the installation must be electrically bonded to the other parts of the aeroplane. (See ACJ 25J901(c)(4).)	
(d) The APU installation must comply with JAR 25.1309, except that the effects of the following need not comply with JAR 25.1309(b) (see ACJ 25.901(c)) : (i) APU case burn through or rupture; and (ii) Uncontained APU rotor failure.	(d) introduction of wording similar to NPA 25EXXX, replacing the current 25A901(c). Air-flow delivery requirements relocated under JAR 25J1106(c). Current JAR 25A901(d) has been deleted, under the same principle used to delete JAR 25.901(e) - see NPA 25E-262. ACJ 25A901(d) is now ACJ 25J1041.

JAR 25 J903 **Auxiliary Power Unit**	Justification :
(a) Each APU must meet the appropriate requirements of JAR-APU for its intended function:	(a) Category 1/2 APUs are qualified under JAR-APU. Essential/non essential APUs are now defined under JAR 25J901(b). APUs are no longer planned to have full Type Certificates.
(1) Essential: Category 1 APU,	
(2) Non-essential: Category 1 or Category 2 APU.	
(c) Control of APU rotation and shut-down capability.	(c) identical to JAR 25A903(c).
(1) It shall be possible to shut down the APU from the flight deck in normal and emergency conditions.	
(2) Where continued rotation of an APU could jeopardise the safety of the aeroplane, there must be a means for stopping rotation. Each component of the stopping system located in the APU compartment must be at least fire resistant.	
(d) For APU installation:	(d) subparagraph heading revised to reflect contents
(1) Design precautions must be taken to minimise the hazards to the aeroplane in the event of an APU rotor failure or of a fire originating within the APU which burns through the APU casing. (See ACJ 20-128A.)	(d)(1) introduction of the harmonised advisory material, ACJ 20-128A - see NPA 25 E/J-287.
(2) The APU system must be designed and installed to give reasonable assurance that APU operating limitations that adversely affect turbine rotor structural integrity will not be exceeded in service.	(d)(2) identical to JAR 25A903(d)(2).
(e) Inflight start capability.	(e) introduction of some new requirements for non-essential APUs that

(1) For non-essential APUs that can be started in flight and all essential APUs- (i) Means must be provided to start the APU in flight, and (ii) An altitude and airspeed envelope must be established and demonstrated for APU inflight starting. (2) For essential APUs- Cold soak must be considered in establishing the envelope of JAR 25J903(e)(1)(ii).	are restartable in flight, based upon current certification practices. For essential APUs, cold soak is included in the requirement and no longer in ACJ 25B903(e), which has been deleted as it had no real safety benefit beyond that.
JAR 25J939 APU operating characteristics	Justification :
(a) APU operating characteristics must be investigated to determine that no adverse characteristics (such as stall, surge, or flame-out) are present, to a hazardous degree, during normal and emergency operation within the range of operation limitations of the aeroplane and of the APU.	(a) text revised, word 'in flight' deleted, making ACJ 25A939(a) redundant. Alleviation for use of stationary APU deleted, as those are no longer available on modern design, and their operating characteristics should be evaluated anyway. Rationale also based upon FAA policy.
(c) The APU air inlet system may not, as a result of air-flow distortion during normal operation, cause vibration harmful to the APU.	(c) identical to current JAR 25A939(c).
(d) It must be established over the range of operating conditions for which certification is required, that the APU installation vibratory conditions do not exceed the critical frequencies and amplitudes established under JAR-APU 120.	(d) identical to current JAR 25A939(d). Although the equivalent engine requirement and its ACJ (JAR 25.939(d) and ACJ 25.939(d)) are proposed to be deleted by NPA 25E,F-315, the proposed wording here is that agreed by the APU ARAC Task Group. It is retained for APUs, on the basis that the installed conditions must not exceed those established during APU approval. The FAA are known to support retention

	of this requirement for APUs.
JAR 25J943 Negative acceleration	Justification :
No hazardous malfunction of an APU or any component or system associated with the APU may occur when the aeroplane is operated at the negative accelerations within the flight envelopes prescribed in JAR 25.333. This must be shown for the greatest duration expected for the acceleration. (See ACJ 25J943.)	JAR 25J943 is identical to current JAR 25A943.
FUEL SYSTEM	
JAR 25J951 General	Justification :
(a) Each fuel system must be constructed and arranged to ensure a flow of fuel at a rate and pressure established for proper APU functioning under each likely operating condition, including any manoeuvre for which certification is requested and during which the APU is permitted to be in operation.	(a) applicability expended to all APUs (instead of essential APUs only), since this requirement is really common sense. This is also harmonising with FAA certification practices.
(b) For essential APUs- Each fuel system must be arranged so that any air which is introduced into the system will not result in flameout.	(b) slight cosmetic changes, considered identical to JAR 25B951(b).
(c) For essential APUs- Each fuel system for an essential APU must be capable of sustained	(c) identical to JAR 25B951(c) - see NPA 25 J-228 introduced in JAR-25 by OP 96/1.

operation throughout its flow and pressure range with fuel initially saturated with water at 26.7 °C and having 0.20 cm^3 of free water per liter added and cooled to the most critical condition for icing likely to be encountered in operation.	
JAR 25J952 Fuel system analysis and test	Justification :
(a) Proper fuel system functioning under all probable operating conditions must be shown by analysis and those tests found necessary by the Agency. Tests, if required, must be made using the aeroplane fuel system or a test article that reproduces the operating characteristics of the portion of the fuel system to be tested. (b) The likely failure of any heat exchanger using fuel as one of its fluids may not result in a hazardous condition.	JAR 25J952 is identical to current JAR 25A952.
JAR 25J953 Fuel system independence	Justification :
Each fuel system must allow the supply of fuel to the APU-	
(a) Through a system independent of each part of the system supplying fuel to the main engines; or	(a) unchanged from JAR 25A953(a).
(b) From the fuel supply to the main engine if provision is made for a shut-off means to isolate the APU fuel line.	(b) ACJ 25A953(b) deleted and its text included directly in the requirement.

JAR 25J955 Fuel flow	Justification :
(a) Each fuel system must provide at least 100 percent of the fuel flow required by the APU under each intended operating condition and manoeuvre. Compliance must be shown as follows:	
(1) Fuel must be delivered at a pressure within the limits specified for the APU.	(a)(1) applicability expended to all APUs (instead of essential APUs only), since this requirement is really common sense.
(2) For essential APUs- (i) The quantity of fuel in the tank may not exceed the amount established as the unusable fuel supply for that tank under the requirements of JAR 25.959 plus that necessary to show compliance with this section. (ii) Each main pump must be used that is necessary for each operating condition and attitude for which compliance with this section is shown, and the appropriate emergency pump must be substituted for each main pump so used. (iii) If there is a fuel flowmeter, it must be blocked and the fuel must flow through the meter or its bypass. <u>(See ACJ 25J955(a)(4).)</u>	(a)(2) is similar to JAR 25B955(a)(2) to (a)(4). ACJ 25J955(a)(4) is new, the current subpart J 25A955(a)(4) was referencing to ACJ 25.955(a)(4), whereas all other subpart J had their dedicated ACJ (if any). ACJ 25J955(a)(4) was adapted directly from ACJ 25.955(a)(4).
(b) For essential APUs- If an APU can be supplied with fuel from more than one tank, the fuel system must, in addition to having appropriate manual switching capability, be designed to prevent interruption of fuel flow to that APU, without attention by the flight crew, when any tank supplying fuel to that APU is depleted of usable fuel during normal operation, and any other tank, that normally supplies fuel to that APU, contains usable fuel.	(b) is unchanged from JAR 25B955(b).

JAR 25J961 Fuel system hot weather operation	Justification :
For essential APUs-	
(a) The fuel supply of an APU must perform satisfactorily in hot weather operation. It must be shown that the fuel system from the tank outlet to the APU is pressurised under all intended operations so as to prevent vapour formation. Alternatively, it must be shown that there is no evidence of vapour lock or other malfunctioning during a climb from the altitude of the airport selected by the applicant to the maximum altitude established as an operating limitation under JAR 25J1527, with the APU operating at the most critical conditions for vapour formation but not exceeding the maximum essential load conditions. If the fuel supply is dependant on the same fuel pumps or fuel supply as the main engines, the main engines must be operated at maximum continuous power.	(a) identical to current JAR 25B961(a), except for reference to JAR 25J1527 instead of JAR 25.1527 since this requirement has been incorporated in subpart J. ACJ 25J961(a)(5) is now proposed to be deleted in the same way as for the deletion of ACJ 25.961(a)(5) in NPA 25E,F-315. There has been no recent record of use of the provisions of this ACJ and if required in future, it could still be an acceptable means of compliance. Deletion of the ACJ does not impact the Harmonisation work.
(5) The fuel temperature must be at least 43°C at the start of the climb.	
(b) The test prescribed in sub-paragraph (a) of this paragraph may be performed in flight or on the ground under closely simulated flight conditions. If a flight test is performed in weather cold enough to interfere with the proper conduct of the test, the fuel tank surfaces, fuel lines, and other fuel system parts subject to cold air must be insulated to simulate, insofar as practicable, flight in hot weather.	(b) identical to current JAR 25B961(b).

JAR 25J977 Fuel tank outlet For essential APUs- (a) There must be a fuel strainer for the fuel tank outlet or for the booster pump. This strainer must prevent the passage of any object that could restrict fuel flow or damage any fuel system component. (b) The clear area of each fuel tank outlet strainer must be at least five times the area of the outlet line. (c) The diameter of each strainer must be at least that of the fuel tank outlet. (d) Each finger strainer must be accessible for inspection and cleaning.	Justification : Identical, except for some minor cosmetic changes, to JAR 25B977.
JAR 25J991 Fuel pumps <u>(See ACJ 25J991)</u> For essential APUs- (a) Main pumps. Each fuel pump required for proper essential APU operation, or required to meet the fuel system requirements of this subpart (other than those in sub-paragraph (b) of this paragraph), is a main pump. For each main pump, provision must be made to allow the bypass of each positive displacement fuel pump other than a fuel pump approved as part of the APU. (b) Emergency pumps. There must be emergency pumps or another main pump to feed an essential APU immediately after failure of any main pump (other than a fuel pump approved as part of the APU).	Justification : (a) identical to current JAR 25B991(a). (b) identical to current JAR 25B991(b).

JAR 25J993 Fuel system lines and fittings	Justification :
(a) Each fuel line must be installed and supported to prevent excessive vibration and to withstand loads due to fuel pressure and accelerated flight conditions.	(a) identical to current JAR 25A993(a).
(b) Each fuel line connected to components of the aeroplane between which relative motion could exist must have provisions for flexibility.	(b) identical to current JAR 25A993(b).
(c) Each flexible connection in fuel lines that may be under pressure and subjected to axial loading must use flexible hose assemblies.	(c) Will be identical to JAR 25A993(c), when the revisions shown in NPA 25E, F-315 are implemented. 'Equivalent means' can always be used, with the approval of the Certification Authorities.
(d) Flexible hose must be approved or must be shown to be suitable for the particular application.	(d) identical to current JAR 25A993(d).
(e) No flexible hose that might be adversely affected by exposure to high temperatures may be used where excessive temperatures will exist during operation or after an APU shut-down.	(e) identical to current JAR 25A993(e).
(f) Each fuel line within the fuselage must be designed and installed to allow a reasonable degree of deformation and stretching without leakage.	(f) identical to current JAR 25A993(f).
JAR 25J994 Fuel system components	Justification :
Fuel system components in the APU compartment or in the fuselage must be protected from damage which could result in spillage of enough fuel to constitute a fire hazard as a result of a wheels-up landing on a paved runway.	The text of JAR 25A994 has been replaced with the text of JAR 25.994 for consistency, as well as harmonisation with FAR 25.994 which has been applied to APU installation.

JAR 25J995 Fuel valves In addition to the requirements of JAR 25J1189 for shut-off means, each fuel valve must be supported so that no loads resulting from their operation or from accelerated flight conditions are transmitted to the lines attached to the valve, unless adequate strength margins under all loading conditions are provided in the lines and connections.	Justification : The text has been slightly revised, and is incorporating the statement "unless adequate strength margins under all loading conditions are provided in the lines and connections" from JAR 25.997(c) which is applicable to similar components. This change is proposed to reflect the common compliance means and reduce number of equivalent safety findings.
JAR 25J997 Fuel strainer or filter For essential APUs- There must be a fuel strainer or filter between the fuel tank outlet and the inlet of either the fuel metering device or an APU driven positive displacement pump, whichever is nearer the fuel tank outlet. This fuel strainer or filter must- (a) Be accessible for draining and cleaning and must incorporate a screen or element which is easily removable; (b) Have a sediment trap and drain except that it need not have a drain if the strainer or filter is easily removable for drain purposes; (c) Be mounted so that its weight is not supported by the connecting lines or by the inlet or outlet connections of the strainer or filter itself, unless adequate strength margins under all loading conditions are provided in the lines and connections; and	Justification : (a) to (d) text is similar to JAR 25B997, except for the addition of "unless adequate strength margins under all loading conditions are provided in the lines and connections" from JAR 25.997(c), in JAR 25J997(c). See JAR 25J995 for justification. Note : as for the main engine fuel filter, no cockpit indication is required.

(d) Have the capacity (with respect to operating limitations established for the APU) to ensure that APU fuel system functioning is not impaired, with the fuel contaminated to a degree (with respect to particle size and density) that is greater than that established for the APU in JAR-APU 250(a).	
OIL SYSTEM **JAR 25J1011 Oil System General** (a) Each APU must have an independent oil system that can supply it with an appropriate quantity of oil at a temperature not above that safe for continuous operation.	Justification : (a) deletion of the need for the oil system to comply with JAR-APU, since this requirement could be conflicting with some design, for instance those featuring an oil reserve in the airframe to refill engines and APUs oil tanks (presumably on ground only).
(b) The usable oil capacity may not be less than the product of the endurance of the aeroplane and the approved maximum allowable oil consumption of the APU plus a suitable margin to ensure system circulation.	(b) is now applicable to all APUs, instead of essential APUs only previously. It was felt dangerous to have APU running out of oil in flight, even if those APUs were not essential.
JAR 25J1017 Oil lines and fittings (a) Each oil line must meet the requirements of JAR 25J993 and each oil line and fitting in any designated fire zone must meet the requirements of JAR 25J1183.	Justification : (a) has been introduced to harmonise with FAA practices, which requires application of FAR 25.1017(a) to APU installation.

(b) Breather lines must be arranged so that- (1) Condensed water vapour that might freeze and obstruct the line cannot accumulate at any point; (2) The breather discharge does not constitute a fire hazard; (3) The breather does not discharge into the APU air intake system.	(b) is similar to JAR 25A1017(b), except for some clarification of (b)(2), and replacement of "air induction system" by "air intake system" in § (b)(3) for clarification purpose.
JAR 25J1019 Oil filter Where there is a filter in the APU lubrication system through which all the oil flows, it must be constructed and installed so that oil may flow at an acceptable rate through the rest of the system with the filter element completely blocked. An impending filter by-pass indication is required.	Justification : This requirement was introduced for APU installation, since it was FAA policy to apply it for all APU's installation (non-essential and essential). The text revised to make rule specific to APUs and to reference current FAA APU certification policy. The impending filter bypass indication requirement (from FAR 25.1019(a)(3)) was also combined with the basic requirement.
JAR 25J1021 Oil system drains A drain (or drains) must be provided to allow safe drainage of the oil system. Each drain must- (a) Be accessible; and (b) Have manual or automatic means for positive locking in the closed position.	Justification : The text is now similar to JAR 25.1021 (and FAR 25.1021), for consistency and harmonisation purposes.

JAR 25J1023 Oil radiators (a) Each oil radiator must be able to withstand, without failure, any vibration, inertia, and oil pressure load to which it would be subjected in operation.	Justification : (a) this requirement was introduced for APU installation, since it was FAA policy to apply it for all APU's installation (non-essential and essential). Paragraph (a) is identical to FAR 25.1023(a). (b) was in fact applicable to reciprocating type engine installation, and has therefore been deleted.
JAR 25J1025 Oil valves (a) Each oil shut-off must meet the requirements of JAR 25J1189. (b) Each oil valve must have positive stops or suitable index provisions in the "on" and "off" positions and must be supported so that no loads resulting from its operation or from accelerated flight conditions are transmitted to the lines attached to the valve, unless adequate strength margins under all loading conditions are provided in the lines and connections.	Justification : (a) is identical to JAR 25A1025(a). (b) is identical to JAR 25A1025(c), with words added to include present generalised component mounting policy covered in JAR 25J995 and JAR 25J997(c).
COOLING **JAR 25J1041 General** The APU cooling provisions must be able to maintain the temperatures of APU components and fluids within the temperature limits established for these components and fluids, under critical ground and flight operating conditions, and after normal APU shutdown. (See ACJ 25J1041.)	Justification : The intent is identical to current JAR 25A1041. The test condition wording was modified to delete specific "water" reference as covered by general APU operating conditions and added the qualifying word "critical" in front to reflect present requirement policy.

	ACJ 25J1041 is introduced, was previously ACJ 25A901(d) (JAR 25A901(d) has been deleted) - see main engine NPA 25E-262 for background.
JAR 25J1043 Cooling tests	Justification :
(a) General. Compliance with JAR 25J1041 must be shown by tests, under critical conditions. For these tests, the following apply:	(a) is essentially the same as JAR 25A1043(a) except modified to be consistent with 25J1041 in the definition of test conditions.
(1) If the tests are conducted under conditions deviating from the maximum ambient atmospheric temperature, the recorded APU temperatures must be corrected under sub-paragraph (c) of this paragraph.	(a)(1) is identical to JAR 25A1043(a)(1).
(2) No corrected temperatures determined under sub-paragraph (a)(1) of this paragraph may exceed established limits.	(a)(2) is identical to JAR 25A1043(a)(2). (a)(3) has been deleted - fuel grade is a reciprocating engine term.
(b) Maximum ambient atmospheric temperature. A maximum ambient atmospheric temperature corresponding to sea level conditions must be established. The temperature lapse rate is 2.0°C per 300 meter of altitude above sea level until a temperature of -56.5°C is reached, above which altitude, the temperature is considered constant at -56.5°C.	(b) paragraph (b) has the same lapse rate definition as JAR 25A1043(b) and FAR 25.1043(b). The specific requirement of 100 degrees F was removed to harmonise with JAR 25A1043(b) but still retain FAR 25.1043(b) wording which JAR subpart J 25A1043(b) adopted.
(c) Correction factor. Unless a more rational correction applies, temperatures of APU fluids and components for which temperature limits are established, must be corrected by adding to them the difference between the maximum ambient atmospheric temperature and the temperature of the ambient air at the time of the first occurrence of the maximum component or fluid temperature recorded during the cooling test.	(c) is identical to JAR 25A1043(c).

JAR 25J1045 Cooling test procedures	Justification :
(a) Compliance with JAR 25J1041 must be shown for the critical conditions that correspond to the applicable performance requirements. The cooling tests must be conducted with the aeroplane in the configuration, and operating under the conditions that are critical relative to cooling. For the cooling tests, a temperature is 'stabilised' when its rate of change is less than 1°C per minute.	(a) intent is similar to current JAR 25A1045(a), but wording has been revised for clarity reason and to be more suitable to APU installation cooling tests.
(b) Temperatures must be stabilised prior to entry into each critical condition being investigated, unless the entry condition normally is not one during which component and APU fluid temperatures would stabilise (in which case, operation through the full entry condition must be conducted before entry into the critical condition being investigated in order to allow temperatures to reach their natural levels at the time of entry).	(b) is similar to JAR 25A1045(b), with wording revision for clarity. Also, take-off condition has been deleted since it is not critical for APU (difference from main engine).
(c) Cooling tests for each critical condition must be continued until- (1) The component and APU fluid temperatures stabilise; (2) The stage of flight is completed; or (3) An operating limitation is reached.	(c) is identical to JAR 25A1043(c).
AIR INTAKE AND BLEED AIR DUCT SYSTEMS	

JAR 25J1091 Air intake	Justification :
The air intake system for the APU-	
(a) Must supply the air required by the APU under each operating condition for which certification is requested,	(a) is derived and identical in intent to JAR 25A1091(a).
(b) May not draw air from within the APU compartment or other compartments unless the inlet is isolated from the APU accessories and power section by a firewall,	(b) is new to JAR-25 subpart J, being derived from FAR 25.1091(c)(1) to harmonise with FAA practices regarding APU installation certification.
(c) Must have means to prevent hazardous quantities of fuel leakage or overflow from drains, vents, or other components of flammable fluid systems from entering,	(c) is similar to JAR 25A1091(d)(1).
(d) Must be designed to prevent water or slush on the runway, taxiway, or other airport operating surface from being directed into the air intake system in hazardous quantities,	(d) is similar in intention to JAR 25A1091(d)(2). See also JAR 25B1091(b)(2).
(e) Must be located or protected so as to minimise the ingestion of foreign matter during takeoff, landing, and taxiing.	(e) is applicable to all APUs, being derived from JAR 25B1091(b)(2).
JAR 25J1093 Air intake system icing protection	Justification :
(a) Each non-essential APU air intake system, including screen if used, which does not comply with JAR 25J1093(b) will be restricted to use in non-icing conditions, unless it can be shown that the APU complete with air intake system, if subjected to icing conditions, will not affect the safe operation of the aeroplane.	(a) is identical to JAR 25A1093(a).

(b) For essential APUs- Each essential APU air intake system, including any screen if used, must enable the APU to operate over the range of conditions for which certification is required without adverse effect or serious loss of power (see ACJ 25J1093(b)(2)): (1) Under the icing conditions specified in Appendix C; and (2) In falling and blowing snow within the limitations established for the aeroplane for such operations.	(b) is identical in the principle to JAR 25B1093(b)(2). The screen requirement of JAR 25B1105 is included in JAR 25.1093(b). JAR 25A1105 has been deleted, since alcohol is no longer used for on-board de-icing. Also, for harmonisation purpose, the falling and blowing snow condition has been included - see JAA NPA 25 E-288 dealing with main engine for background. Once this NPA will be published, ACJ reference will be incorporated in subpart J.
JAR 25J1103 Air intake system ducts	Justification :
(a) Each air intake system duct must be-	
(1) Drained to prevent accumulation of hazardous quantities of flammable fluid and moisture in the ground attitude. The drain(s) must not discharge in locations that might cause a fire hazard; and	(a)(1) intent similar to current JAR 25A1103(a), but simplified for clarity reasons.
(2) Constructed of materials that will not absorb or trap sufficient quantities of flammable fluids such as to create a fire hazard,	(a)(2) is derived from JAR 25A1103(e), being written in a more generic way.
(b) Each duct must be-	
(1) Designed to prevent air intake system failures resulting from reverse flow, APU surging, or inlet door closure; and	(b)(1) is derived from JAR 25A1103(b)(1), typical APU failure cases (reverse flow and inlet door closure) have been included.
(2) Fireproof within the APU compartment and for a sufficient distance	(b)(2) is combining fireproofness requirements outside of the APU

upstream of the APU compartment to prevent hot gases reverse flow from burning through the APU air intake system ducts and entering any other compartment or area of the aeroplane in which a hazard would be created resulting from the entry of hot gases. The materials used to form the remainder of the air intake system duct and plenum chamber of the APU must be capable of resisting the maximum heat conditions likely to occur.	compartment from JAR 25A1103(b)(2) (it is based upon FAR 25.1103(e), for harmonisation purposes).
(c) Each duct connected to components between which relative motion could exist must have means for flexibility.	(c) is derived from JAR 25A1103(c).
JAR 25J1106 Bleed air duct systems	Justification :
(a) For APU bleed air duct systems, no hazard may result if a duct failure occurs at any point between the air duct source and the aeroplane unit served by the bleed air. (b) Each duct connected to components between which relative motion could exist must have a means for flexibility.	A new paragraph, JAR 25J1106, was added to consolidate and harmonise miscellaneous APU bleed air duct system requirements (from the FARs and JARs) into a common subpart J requirement. It was determined that it would be beneficial to have one rule paragraph dedicated to APU intake ducts (25J1103) and another rule paragraph dedicated to APU bleed air ducts (25J1106):
(c) Where the airflow delivery from the APU and main engine is delivered to a common manifold system, precautions must be taken to minimise the possibility of a hazardous condition due to reverse airflow through the APU resulting from malfunctions of any component in the system.	(a) is identical to JAR 25A1103(d) (b) is identical to JAR 25A1103(c) (c) is similar to the bleed air duct requirement found in JAR 25A901(c).
EXHAUST SYSTEM	

JAR 25J1121 General	Justification :
(a) Each exhaust system must ensure safe disposal of exhaust gases without fire hazard or carbon monoxide contamination in any personnel compartment. For test purposes, any acceptable carbon monoxide detection method may be used to show the absence of carbon monoxide.	(a) is identical to JAR 25A1121(a)
(b) Each exhaust system part with a surface hot enough to ignite flammable fluids or vapours must be located or shielded so that leakage from any system carrying flammable fluids or vapours will not result in a fire caused by impingement of the fluids or vapours on any part of the exhaust system including shields for the exhaust system.	(b) is identical to FAR 25.1121(b) and JAR 25.1121(b).
(c) Each component that hot exhaust gases could strike, or that could be subjected to high temperatures from exhaust system parts, must be fireproof. All exhaust system components must be separated by fireproof shields from adjacent parts of the aeroplane that are outside the APU compartment.	(c) is identical to JAR 25A1121(c).
(d) No exhaust gases may discharge so as to cause a fire hazard with respect to any flammable fluid vent or drain.	(d) is identical to JAR 25A1121(d). (e) was deleted as the design addressed by this requirement is considered obsolete for part 25 aircraft (i.e. APU installed in front of pilot compartment).
(f) Each exhaust system component must be ventilated to prevent points of excessively high temperature.	(f) is identical to JAR 25A1121(f)
(g) Each exhaust shroud must be ventilated or insulated to avoid, during normal operation, a temperature high enough to ignite any flammable	(g) is identical to JAR 25A1121(g)

fluids or vapours external to the shroud.	
JAR 25J1123 Exhaust piping	Justification :
(a) Exhaust piping must be heat and corrosion resistant, and must have provisions to prevent failure due to expansion by operating temperatures.	JAR 25J1123 is identical to JAR 25A1123.
(b) Piping must be supported to withstand any vibration and inertia loads to which it would be subjected in operation; and	
(c) Piping connected to components between which relative motion could exist must have means for flexibility.	
APU CONTROLS AND ACCESSORIES	
JAR 25J1141 APU controls	Justification : this paragraph was extensively revised to take into account specific APU control design and installation characteristics as well as currently applied certification policies (i.e. unattended APU operation and remote controls location).
(a) Means must be provided on the flight deck for starting, stopping, and emergency shutdown of each installed APU. Each control must-	(a) is identical to FAR 25.1142(a).
(1) Be located, arranged, and designed under JAR 25.777(a)(b)(c)(d) and	(a)(1) is similar to general provisions JAR 25A1141(a)(1) except the list of

marked under JAR 25.1555(a); and	referenced paragraphs (25.777 and 25.1555) was revised to limit the list to APU relevant requirements.
(2) Be located so that it cannot be inadvertently operated by persons entering, leaving, or moving normally on the flight deck; and	(a)(2) is identical to current JAR 25.1141(a) (with very minor wording changes).
(3) Be able to maintain any set position without constant attention by flight crew members and without creep due to control loads or vibration; and	(a)(3) is identical to current JAR 25A1141(d).
(4) Have sufficient strength and rigidity to withstand operating loads without failure and without excessive deflection; and	(a)(4) is identical to current JAR 25A1141(c).
(5) For flexible controls, be approved or must be shown to be suitable for the particular application.	(a)(5) is identical to current JAR 25A1141(b).
(b) APU valve controls located in the flight deck must have- (1) For manual valves, positive stops or, in the case of fuel valves, suitable index provisions in the open and closed positions, (2) In the case of valves controlled from the flight deck other than by mechanical means, where the correct functioning of the valve is essential for the safe operation of the aeroplane, a valve position indicator which senses directly that the valve has attained the position selected must be provided, unless other indications in the flight deck give the flight crew a clear indication that the valve has moved to the selected position. A continuous indicator need not be provided.	(b) is similar to JAR 25A1141(f). It is dealing only with valve located on the flight deck.
(c) For unattended operation, the APU must:	(c) is new. It is based on current industry practices for unattended APU operation.

(1) Provide means to automatically shutdown the APU for the following conditions : (i) Exceedance of any APU parameter limit or existence of a detectable hazardous APU operating condition; and (ii) Bleed air duct failure between the APU and aeroplane unit served by the bleed air, unless it can be shown that no hazard exists to the aeroplane.	(1) requires protection by auto-shutdown from a detectable hazardous operating condition.
(2) Provide means to automatically shut off flammable fluids per JAR 25J1189 in case of fire in the APU compartment.	(2) address the specific fire condition by requesting shut off of flammable fluids.
(d) APU controls located elsewhere on the aeroplane, which are in addition to the flight deck controls, must meet the following requirements :	(d) is also new, but is really only reflecting the cockpit requirement for controls located elsewhere on the aircraft (typically, in the front wheel well).
(1) Each control must be located so that it cannot be inadvertently operated by persons entering, leaving, or moving normally in the area of the control; and	(1) is similar to the flight deck requirement of JAR 25J1141(a)(2).
(2) Each control must be able to maintain any set position without creep due to control loads, vibration, or other external forces resulting from the location.	(2) is similar to the flight deck requirement of JAR 25J1141(a)(3).
(e) The portion of each APU control located in a designated fire zone that is required to be operated in the event of a fire must be at least fire resistant.	(e) is new to subpart J, but is in fact correcting the failure to implement in this subpart the equivalent of JAR 25.1141(e), which has been introduced in JAR-25 by OP 93/1.
JAR 25J1163 APU accessories	Justification :

(a) APU mounted accessories must be approved for installation on the APU concerned and use the provisions of the APU for mounting.	(a) is identical to current JAR 25A1163(a).
(b) Electrical equipment subject to arcing or sparking must be installed to minimise the probability of contact with any flammable fluids or vapours that might be present in a free state.	(b) is identical to current JAR 25A1163(b).
(c) For essential APUs- If continued rotation of a failed aeroplane accessory driven by the APU affects the safe operation of the aeroplane, there must be means to prevent rotation without interfering with the continued operation of the APU.	(c) is similar in intent to JAR 25B1163(c), but has been reworded to be more specific to APU installation and for clarification.
JAR 25J1165 APU ignition systems	Justification :
Each APU ignition system must be independent of any electrical circuit except those used for assisting, controlling, or analysing the operation of that system.	Requirement identical to JAR 25B1165, wording clarified, and applicability extended to all APUs since it is really describing a common design practice.
APU FIRE PROTECTION	

JAR 25J1181 Designated fire zone (a) Any APU compartment is a designated fire zone. (b) Each designated fire zone must meet the requirements of JAR 25J1185 through JAR 25J1203.	Justification : JAR 25J1181 is identical to current JAR 25A1181.
JAR 25J1183 Lines, fittings and components (a) Except as provided in sub-paragraph (b) of this paragraph, each line, fitting, and other component carrying flammable fluid in any area subject to APU fire conditions, and each component which conveys or contains flammable fluid in a designated fire zone must be fire resistant, except that flammable fluid tanks and supports in a designated fire zone must be fireproof or be enclosed by a fireproof shield unless damage by fire to any non-fireproof part will not cause leakage or spillage of flammable fluid. Components must be shielded or located to safeguard against the ignition of leaking flammable fluid.	Justification : Similar to JAR 25A1183(a), however, the integral oil sump of 20 quarts reference was deleted. This sump was in fact addressing reciprocating engine in FAR 25.1183(a), its inclusion in JAR-25 subpart J was a mistake.
(b) Sub-paragraph (a) of this paragraph does not apply to- (1) Lines and fittings already approved as part of an APU, and (2) Vent and drain lines, and their fittings, whose failure will not result in, or add to, a fire hazard.	(b) identical to current JAR 25A1183(b).
(c) All components, including ducts, within a designated fire zone which, if damaged by fire could result in fire spreading to other regions of the aeroplane, must be fireproof. Those components within a designated fire	(c) identical to current JAR 25A1183(c).

zone, which could cause unintentional operation of, or inability to operate essential services or equipment, must be fireproof.	
JAR 25J1185 Flammable fluids	Justification :
(a) No tank or reservoir that is a part of a system containing flammable fluids or gases may be in a designated fire zone unless the fluid contained, the design of the system, the materials used in the tank, the shut-off means, and all connections, lines, and controls provide a degree of safety equal to that which would exist if the tank or reservoir were outside such a zone.	(a) similar to JAR 25A1185(a), the reference to the integral oil sump specified in JAR 25.1013(a) has been deleted since in fact it was addressing reciprocating engine, and was deleted from JAR 25.1013(a) accordingly !
(b) There must be at least 12,7 mm of clear airspace between each tank or reservoir and each firewall or shroud isolating a designated fire zone.	(b) is identical to current JAR 25A1185(b).
(c) Absorbent materials close to flammable fluid system components that might leak must be covered or treated to prevent the absorption of hazardous quantities of fluids.	(c) is identical to current JAR 25A1185(c).
JAR 25J1187 Drainage and ventilation of fire zones	Justification :
(a) There must be complete drainage of each part of each designated fire zone to minimise the hazards resulting from failure or malfunctioning of any component containing flammable fluids. The drainage means must be- (1) Effective under conditions expected to prevail when drainage is	JAR 25J1187 is identical to current JAR 25A1187.

needed; and (2) Arranged so that no discharged fluid will cause an additional fire hazard. (b) Each designated fire zone must be ventilated to prevent the accumulation of flammable vapours. (c) No ventilation opening may be where it would allow the entry of flammable fluids, vapours, or flame from other zones. (d) Each ventilation means must be arranged so that no discharged vapours will cause an additional fire hazard. (e) Unless the extinguishing agent capacity and rate of discharge are based on maximum air flow through a zone, there must be means to allow the crew to shut off sources of forced ventilation to any fire zone.	
JAR 25J1189 Shut-off means (a) Each APU compartment specified in JAR 25J1181(a) must have a means to shut-off or otherwise prevent hazardous quantities of flammable fluids, from flowing into, within, or through any designated fire zone, except that shut-off means are not required for- (1) Lines, fittings and components forming an integral part of an APU, and (2) Oil systems for APU installations in which all external components of the oil system, including the oil tanks, are fireproof.	Justification : JAR 25J1189 is identical to current JAR 25A1189.

(b) The closing of any fuel shut-off valve for any APU may not make fuel unavailable to the main engines. (c) Operation of any shut-off may not interfere with the later emergency operation of other equipment. (d) Each flammable fluid shut-off means and control must be fireproof or must be located and protected so that any fire in a fire zone will not affect its operation. (e) No hazardous quantity of flammable fluid may drain into any designated fire zone after shut-off. (f) There must be means to guard against inadvertent operation of the shut-off means and to make it possible for the crew to reopen the shut-off means in flight after it has been closed. (g) Each tank to APU shut-off valve must be located so that the operation of the valve will not be affected by the APU mount structural failure. (h) Each shut-off valve must have a means to relieve excessive pressure accumulation unless a means for pressure relief is otherwise provided in the system.	
JAR 25J1191 Firewalls (a) Each APU must be isolated from the rest of the aeroplane by firewalls, shrouds, or equivalent means.	Justification : JAR 25J1191 is identical to current JAR 25A1191.

(b) Each firewall and shroud must be- (1) Fireproof; (2) Constructed so that no hazardous quantity of air, fluid, or flame can pass from the compartment to other parts of the aeroplane; (3) Constructed so that each opening is sealed with close fitting fireproof grommets, bushings, or firewall fittings; and (4) Protected against corrosion.	
JAR 25J1193 APU compartment (a) Each compartment must be constructed and supported so that it can resist any vibration, inertia, and air load to which it may be subjected in operation. (b) Each compartment must meet the drainage and ventilation requirements of JAR 25J1187. (d) Each part of the compartment subject to high temperatures due to its nearness to exhaust system parts or exhaust gas impingement must be fireproof. (e) Each aeroplane must- (1) Be designed and constructed so that no fire originating in any APU fire zone can enter, either through openings or by burning through external skin, any other zone or region where it would create	Justification : JAR 25J1193 is identical to JAR 25A1193, except that the words “APU compartment” were substituted for the word “cowling”. This revision was deemed necessary as the structure surrounding most APU installations is not typically referred to as “cowling”.

additional hazards, (2) Meet sub-paragraph (e)(1) of this paragraph with the landing gear retracted (if applicable), and (3) Have fireproof skin in areas subject to flame if a fire starts in the APU compartment.	
JAR 25J1195 Fire extinguisher systems (a) There must be a fire extinguisher system serving the APU compartment. (b) The fire extinguishing system, the quantity of the extinguishing agent, the rate of discharge, and the discharge distribution must be adequate to extinguish fires. An individual 'one shot' system is acceptable. (See ACJ 25J1195(b).) (c) The fire-extinguishing system for an APU compartment must be able to simultaneously protect each zone of the APU compartment for which protection is provided.	Justification : JAR 25J1195 is identical to current JAR 25A1195.
JAR 25J1197 Fire extinguishing agents (a) Fire extinguishing agents must- (1) Be capable of extinguishing flames emanating from any burning of fluids or other combustible materials in the area protected by the fire extinguishing system; and	Justification : JAR 25J1197(a) is identical to current JAR 25A1197(a).

(2) Have thermal stability over the temperature range likely to be experienced in the compartment in which they are stored.	
(b) If any toxic extinguishing agent is used, provisions must be made to prevent harmful concentrations of fluid or fluid vapours (from leakage during normal operation of the aeroplane or as a result of discharging the fire extinguisher on the ground or in flight) from entering any personnel compartment, even though a defect may exist in the extinguishing system.	JAR 25J1197(b) is identical to JAR 25A1197(b) except that the text concerning "built-in carbon dioxide fuselage compartment fire extinguishing systems" was not included in this revised subpart J requirement as it was determined that this type of extinguishing system is not in use on APUs.
JAR 25J1199 Extinguishing agent containers	Justification :
(a) Each extinguishing agent container must have a pressure relief to prevent bursting of the container by excessive internal pressures.	JAR 25J1199 is identical to current JAR 25A1199.
(b) The discharge end of each discharge line from a pressure relief connection must be located so that discharge of the fire extinguishant agent would not damage the aeroplane. The line must be located or protected to prevent clogging caused by ice or other foreign matter.	
(c) There must be a means for each fire extinguishing agent container to indicate that the container has discharged or that the charging pressure is below the established minimum necessary for proper functioning.	
(d) The temperature of each container must be maintained, under intended operating conditions, to prevent the pressure in the container from-	
(1) Falling below that necessary to provide an adequate rate of discharge; or	

(2) Rising high enough to cause premature discharge. (e) If a pyrotechnic capsule is used to discharge the extinguishing agent, each container must be installed so that temperature conditions will not cause hazardous deterioration of the pyrotechnic capsule.	
JAR 25J1201 Fire extinguishing system materials (a) No material in any fire extinguishing system may react chemically with any extinguishing agent so as to create a hazard. (b) Each system component in an APU compartment must be fireproof.	Justification : JAR 25J1201 is identical to current JAR 25A1201.
JAR 25J1203 Fire-detector system (a) There must be approved, quick acting fire or overheat detectors in each APU compartment in numbers and locations ensuring prompt detection of fire. (b) Each fire detector system must be constructed and installed so that- (1) It will withstand the vibration, inertia, and other loads to which it may be subjected in operation; (2) There is a means to warn the crew in the event that the sensor or associated wiring within a designated fire zone is severed at one point, unless the system continues to function as a satisfactory	Justification : JAR 25J1203 is identical to current JAR 25A1203.

detection system after the severing; and

(3) There is a means to warn the crew in the event of a short circuit in the sensor or associated wiring within a designated fire zone, unless the system continues to function as a satisfactory detection system after the short circuit.

(c) No fire or overheat detector may be affected by any oil, water, other fluids, or fumes that might be present.

(d) There must be means to allow the crew to check, in flight, the functioning of each fire or overheat detector electric circuit.

(e) Wiring and other components of each fire or overheat detector system in a fire zone must be at least fire-resistant.

(f) No fire or overheat detector system component for any fire zone may pass through another fire zone, unless-

(1) It is protected against the possibility of false warnings resulting from fires in zones through which it passes; or

(2) Each zone involved is simultaneously protected by the same detector and extinguishing system.

(g) Each fire detector system must be constructed so that when it is in the configuration for installation it will not exceed the alarm activation time approved for the detectors using the response time criteria specified in the appropriate ETSO or an acceptable equivalent, for the detector.

JAR 25J1207 Compliance Unless otherwise specified, compliance with the requirements of JAR 25J1181 through JAR 25J1203 must be shown by a full scale test or by one or more of the following methods: (a) Tests of similar APU installations. (b) Tests of components. (c) Service experience of aircraft with similar APU installations. (d) Analysis unless tests are specifically required.	Justification : JAR 25J1207 is very similar to JAR 25A1207, however, the wording has been changed in the introductory sentence to be identical to JAR 25.1207 and FAR 25.1207, for consistency and harmonisation purposes.
GENERAL **JAR 25J1305 APU instruments** (a) The following instruments are required for all installation: (1) A fire warning indicator. (2) An indication than an APU auto-shutdown has occurred. (3) Any other instrumentation necessary to assist the flight crew in- (i) Preventing the exceedance of established APU limits, and	Justification : JAR 25J1305 has been modified, to reflect the APU indication certification methods currently being used for aeroplanes with essential and non-essential APUs employing the "dark cockpit" indication philosophy. This revised methodology has been regularly accepted by the JAA as direct compliance and by the FAA as equivalent safety to the existing 25.1305 indication requirements. JAR 25A1305 was redacted before auto-shudown protections were introduced, and the new JAR 25J1305(a) text is taking into account such features. It is otherwise very similar in its intention to JAR 25A1305(a).

(ii) Maintaining continued safe operation of the APU. (4) Instrumentation per sub-paragraph (3) need not be provided if automatic features of the APU and its installation provide a degree of safety equal to having the parameter displayed directly.	
(b) For essential APUs- In addition to the items required by JAR 25J1305(a), the following indicators are required for an essential APU installation: (1) An indicator to indicate the functioning of the ice protection system, if such a system is installed; and (2) An indicator to indicate the proper functioning of any heater used to prevent ice clogging of fuel system components.	JAR 25J1305(b) is equivalent to JAR 25B1305, and was revised along the line of NPA 25J-246, however, the list of instrument "required but..." was not included, since this was as such quite a "weak" requirement, and all current designs do not feature such instrumentation.
JAR 25J1337 APU instruments (d) There must be a stick gauge or equivalent means to indicate the quantity of oil in each tank.] **OPERATING LIMITATIONS**	Justification : Requirements relating to the instrument lines noted in the JAR 25A1337(a)(1) to (a)(3) were omitted as present installation practices do not employ this technology. For harmonisation purpose, and to be consistent with the new requirement (at least, for non-essential APUs), JAR 25J1337(d) was introduced. It should be noted all current APUs have such feature.

JAR 25J501 General (b) The operating limitations and other information necessary for safe operation must be made available to the crew members as prescribed in JAR 25J1549, 25J1551, and 25J1583.	Justification : Introduced for harmonisation purposes, this requirement is similar to 25.1501(b) except that the JAR 25J1501 requirement references APU specific regulations.
JAR 25J1521 APU limitations The APU limitations must be established so that they do not exceed the corresponding approved limits for the APU and its systems. The APU limitations, including categories of operation, must be specified as operating limitations for the aeroplane.	Justification : Current JAR-25 has two redundant requirements on the subject, JAR 25A1521 and JAR 25.1522. Apparently, 25.1522 was introduced in JAR-25 after an amendment to FAR 25, no consideration being given to subpart J. JAR 25J1521 is combining both, allowing harmonisation between FAR and JAR, and deletion of JAR 25.1522.
JAR 25J1527 Ambient air temperature and operating altitude The extremes of the ambient air temperature and operating altitude for which operation is allowed, as limited by flight, structural, APU installation, functional, or equipment characteristics must be established. **MARKINGS AND PLACARDS**	Justification : JAR 25J1527 is identical to current JAR 25A1527.

25J1549 APU instruments For each APU instrument either a placard or colour markings or an acceptable combination must be provided to convey information on the maximum and (where applicable) minimum operating limits. Colour coding must comply with the following:- (a) Each maximum and, if applicable, minimum safe operating limit must be marked with a red radial or a red line; (b) Each normal operating range must be marked with a green arc or green line, not extending beyond the maximum and minimum safe limits; (c) Each precautionary operating range must be marked with a yellow arc or a yellow line; and (d) Each APU speed range that is restricted because of excessive vibration stresses must be marked with red arcs or red lines.	Justification : JAR 25J1549 is identical to current JAR 25A1549.
JAR 25J1551 Oil quantity indicator Each oil quantity indicator must be marked with enough increments to indicate readily and accurately the quantity of oil. **JAR 25J1557 Miscellaneous markings and placards**	Justification : JAR 25J1551 is identical to current JAR 25A1551.

(b) *APU fluid filler openings* (2) Oil filler openings must be marked at or near the filler cover with the word "oil". **AEROPLANE FLIGHT MANUAL** **JAR 25J1583 Operating limitations** APU limitations established under JAR 25J1521 and information to explain the instrument markings provided under JAR 25J1549 and JAR 25J1551 must be furnished.	Justification : This requirement has been introduced for harmonisation purposes, and is a direct adaptation to APU installation of FAR/JAR 25.1557(a)(2). Justification : JAR 25J1583 is identical to current JAR 25A1583.

4 Economic impact evaluation assessment

The basic intention of this NPA is to introduce an harmonised text between FAR 25 and JAR-25. The economic impact of such an NPA would be to reduce cost of certification in Europe and in the United States, by reducing the work to show compliance finding to a single APU installation set of requirements.

The Terms of Reference (TOR) given to the APU Task Group recommended avoiding creating any new requirements, beyond those found mainly in the current JAR-25 subpart J and FAR 25 subpart E. Inevitably, some paragraphs were obviously obsolete due to changes in APU installation technologies, and minimal changes had to be made. However, those changes are based on current practices only. Therefore, the very few new requirements are based upon current design or certification practices and thus should not incur new work to show compliance finding.

The overall assessment is that the proposed harmonised requirements of subpart J would result in a small cost saving in the compliance demonstration process.

I-D. JAA NPA 25J-300 COMMENT-RESPONSE DOCUMENT

(3 March 2003)

This document provides responses to comments on the above NPA, provided in JAA letter, dated 4 July 2002. The responses, given in the table below, use the same numbering, as in the JAA letter. As this has been a Harmonisation project, no commitment will be made here about revisions to the text, but, where appropriate, recommendations will be made.

Commentors are advised that the main purpose of the work behind the production of NPA 25J-300 was to produce a Harmonised text with FAR 25. Although the opportunity was taken to introduce some revisions, this was never intended to be a detailed scrutiny of all the requirements.

A number of comments relate to the need to revise references to JAR-APU. When writing Harmonised texts for JAR-25, the lack of Harmonised numbering for engine, APU and propeller requirements, will always cause unnecessary extra work. JAA should consider what mechanism can be used, to make sure that changes to one JAR code can be properly reflected in other affected codes.

Comment	Response
JAR 25J901(a) The wording "the APU includes" is confusing. This "definition" of an APU is not definition of the "engine", which is given in (a)(1), but definition of the "APU installation" as explained in the justification table. Therefore, this should be changed into "APU installation" to be consistent with the justification. 3.2 Paragraph (a)(1) contains a definition of an APU which has been approved for incorporation into JAR-1 by means of NPA-1-11 (final version approved, waiting for publication in next amendment to JAR-1). Duplication would not be a real issue if texts were identical : this is not the case. Then, this "definition" should be deleted from JAR-25. 3.3 In English English, the official language for JARs, "which" is preferred to "that". 3.4 In (a)(3), there is a circular argument when the definition of the installation is linked to anything affecting the installation : the complete aircraft would be included in such definition. 3.5 It is suggested to re-write this paragraph as follows (changes are underlined) : (a) For the purpose of this subpart, the APU <u>installation</u> includes (1) <u>The APU</u>,	3.1 Agreed. The term 'APU Installation' will be recommended, to be consistent with the equivalent requirement in Subpart E, for the engine installation. It is recommended that JAR 25J901(a) be revised to read: "(a) For the purpose of this subpart, the APU installation includes: …". 3.2 Not agreed. The proposed definition will remain, since there is some doubt about the continued availability of JAR-1 in the EASA system. No difficulties are expected as a result of small definition differences. 3.3 Noted. 3.4 Agreed. With the above recommendation to use the term 'APU Installation', it will be recommended that JAR25J901(a)(3) reads: "(3) Each component that affects the safety of the APU.". 3.5 Not agreed. The above recommendations will be made. 3.6 Not agreed. The current proposal is consistent with previous JAR-25. the whole Subpart is 'APU Installations'.

(2) Each component which affects the control of the APU, (3) Each component which affects the safety of operation of the APU. 3.6 To be consistent, it is also suggested to change the title of 25J901 to be "APU installation".	
JAR 25J901(b) Definitions of essential and non-essential APU have been deleted from JAR-1 by means of NPA-1-11 (final version approved, waiting for publication in next amendment to JAR-1). The justification needs to be up-dated.	Noted. The JAR-1 comment was valid at the time of preparing the NPA.
JAR 25J901(c)(1) According to the justification and title of 25J901, the subject is "APU installation". Then (c)(1) is confusing when using either "APU" alone or "installation" alone. It is suggested to change the text to read as follows (changes are underlined) : (c) For each APU installation- (1) The APU installation must comply with	Not agreed. The proposed format is unchanged from that in the current Subpart J and which has not caused difficulties.

JAR 25J901(c)(1)(i) and (iii) It is difficult to understand why there are two separate sub-paragraphs requiring the same thing. This text states simply the following : "non-essential APUs must comply with the applicable provisions of this sub-part" and "essential APUs must comply with the applicable provisions of this sub-part". In other words, this states that "APUs must comply with the applicable provisions of this sub-part" which is a more than obvious requirement. It is suggested to delete (iii) and to change (ii) to read as follows : (ii) the applicable provisions of this sub-part.	Not agreed. There are many ways this could be written. The current proposal has the benefit of making it clear from the start, that there are different requirements for 'essential' and non-essential' APUs.
JAR 25J901(c)(2), (3) and (4) According to the justification and title of 25J901, the subject is "APU installation". Then (c)(2) is confusing when using "installation" alone. Same comment for (c)(3) and (c)(4) It is suggested to change the text to use the wording "<u>APU</u> installation".	Not agreed. There is no change from the current wording of JAR 25A901(c)(2)(3) and (4).
JAR 25J903 3.1 The comment on the type certificate for APU cannot be understood : the requirement for an APU TC is not part of this NPA and it is not part of current JAR-25. The question of TC for APUs might be resurrected some day but is agreed that this NPA should go forward without waiting for such a change.	3.1 Noted. 3.2 The term 'APU' may be deduced from the title of Subpart J. 3.3 The proposed Subpart J carries on a 20 year tradition of using, where possible, the equivalent section numbering as in Subpart E. 3.4 This requirement relates to largely to capabilities of the APU itself. The wording follows principles not previously found lacking. No revisions will be recommended.

3.2 The title defines in full letters what APU stands for. But "APU" appears before, in 901 ! The word "APU" should be defined in 901, for example in title of 901 as follows : JAR 25J901 Auxiliary Power Unit (APU) Installation 3.3 It is noted that there is no sub-paragraph (b). This is confusing. 3.4 There is some confusion in the wording. The title of 25J903 is Auxiliary Power Unit : is this only the APU or is it the APU installation ? If it is the APU, then 903 (d), referring to the APU installation, would be out of place. If it is the "APU installation" then the title would be same as for 901, and this would be confusing. Furthermore, we find "APU system" in 903 (d)(2) : what is this ? It is suggested to delete the sub-title ("for APU installation") in 903 (d) and to define "APU system".	
JAR 25J903(c)(2) Some in-service events occurred (including non contained APU failures with punctures in the aircraft pressure bulkhead) where the APU continued to run (in over-speed condition) because of the de-icing fluid ingested through the air inlet. It is assumed that puncture of the bulkhead would be classified as jeopardising the safety of the aeroplane. Then, it would appear that 25J903(c)(2), as currently worded, is applicable to such cases. Does this 25J903(c)(2) requirement impose a physical means to stop the APU rotation (the usual fuel shut-off valve is obviously not efficient when the flammable fluid is in the air swallowed by the APU) ? Is this the intent ?	Noted. The subject of de-icing fluid ingestion is not anticipated by Subpart J. The subject will be raised as a possible PPSG work item.

As an interim solution, it is proposed to change the text as follows : (c)(2) Except in case of ingestion of flammable fluid through the APU air inlet, when continued rotation …. It is recommended to address in the appropriate place in JAR-25 the known problem of ingestion of de-icing fluid.	
JAR 25J903(d)(2) The wording "APU system" is not defined. The statement in the justification of the NPA is not true : the wording is not identical to JAR 25A903 (d)(2). This requirement of (d)(2) is very close to FAR 33.27 (b) which is obviously an engine design requirement. Therefore, this text cannot be understood as written and furthermore it looks like a design requirement for the APU itself. This text should either be deleted from JAR-25 or be transformed into an aircraft requirement, not an APU design requirement.	Agreed. A recommendation will be made to restore the (near) original wording of JAR 25A903(d)(2): "(2) The ~~power-plant~~ systems associated with APU control devices, systems, and instrumentation, must be designed to give reasonable assurance that those APU operating limitations that adversely affect turbine rotor structural integrity will not be exceeded in service."
JAR 25J903(e) 3.1 The text uses "inflight" and "in flight". Only one spelling should be used. Should it be "in-flight" ? 3.2 In (e)(2), the "envelope of JAR 25J903(e)(1)(ii)" is a curious wording. Should it be "envelope required under JAR 25J903(e)(1)(ii)" ?	The word 'inflight' should be spelled 'in-flight' and is an adjective. The words 'in flight', used elsewhere in JAR 25J903 constitute a phrase and do not need changing - 'onground' anybody? JAA will be recommended to make the appropriate revisions in JAR 25J903(e) and elsewhere.

JAR 25J393(a) This requirement is obviously a duplication of the "certification" activity performed on the APU itself and therefore should not be part of JAR-25. It is reminded that JAR-APU contains the following JAR-APU 80 OPERATING CHARACTERISTICS (a) The overall range for APU operating characteristics must be substantiated. This includes the envelopes within which the APU can be started and operated without detrimental effects (such as stall, surge, or flame-out). JAR-25 should be limited to a check of compatibility of the installation with the operating characteristics identified during the APU "certification" in a manner similar to the proposed 939 (d).	Not agreed. These words are currently used for APU (and engine) in '939'.
JAR 25J939(b) There is no sub-paragraph (b)? Why ?	The proposed Subpart J carries on a 20 year tradition of using, where possible, the equivalent section numbering as in Subpart E.
JAR 25J393(c) 3.1 The use of the word "vibration" is confusing because the referenced JAR-APU paragraph is related to "mount loads". 3.2 As written, this JAR-25 text is a requirement for APU "certification". This is not normal. 3.3 It should be noted that both TSO C77 b and JAR-APU have new requirements (in place of those of 6.18) as follows : JAR-APU 120 MOUNTS LOADS The maximum static and dynamic loads, including those that	Comments not understood. There is no JAR-APU paragraph referenced in JAR 25J939(c).

result from APU seizure or imbalance under a failed blade condition, and the critical vibration amplitudes and frequencies which could be transmitted by the APU from the mounting points to the airframe through the normal operating range of the APU must be established and included in the instructions for installation. 3.4 Consequently, JAR-25 should require a check of the design of the mounts so that they would be capable of the loads identified from APU "certification". The following could be considered : (d) The mounting structure of the APU must be capable the critical vibration amplitudes and frequencies which could be transmitted by the APU from the mounting points to the airframe through the normal operating range of the APU, which are described in the APU instructions for installation.	
JAR 25J951(c) The units used in this paragraph are not consistent in that they mix metric and non-metric units (cm3 per gallon !). The references to non-metric units should be deleted and every figure be converted in a metric value (cm3 per litre, for example).	Agreed. JAA will be recommended to use the same units as in JAR-25.951(c).
JAR 25J952(a) 3.1 The use of the words "and those tests found necessary by the Authority" is not acceptable. The times when the requirements were not published and left to arbitrary decision by the authority were ended. 3.2 Furthermore, this is no longer consistent with JAR-21 DOA concept which imposes to the applicant to determine compliance with the requirements (JAR 21.20 (a)) and allows the	Comment (Use of phrase 'tests found necessary by the Authority') will be passed to Central JAA for consideration.

authority to accept this demonstration without further verification (JAR 21.A263 (a)). 3.3 This text must be modified with a clear definition of the tests which would be necessary for compliance.	
JAR 25J953(b) This requirement is not clear. Does it really impose to shut the fuel supply to the main engine and to continue to supply fuel to the APU ? The proposed text is totally ambiguous on the location of the shut-off means : in the line to the main engine or in the line to the APU ? In both cases the APU line would be isolated.	Not agreed. 'Isolation of the APU line' cannot be construed as meaning 'isolation of the engine fuel supply.
JAR 25J955(a)(1) The requirement for all APUs is contained in the first sentence of (a) : it is related to fuel flow (note that this is also the title of the paragraph 955). The remaining part of (a) is simply a means of compliance. For a non-essential APU, only (1) would be applicable. Therefore, for a non-essential APU, if the fuel pressure is OK then there is no need to demonstrate that the fuel flow is OK. This is very curious.	Not agreed. The Harmonised position is that all APUs should have the correct fuel flow for proper operation of the APU during intended operations. This supports compliance with JAR 25.1301.
JAR 25J955(a)(2)(i) 3.1 The requirement for all APUs is contained in the first sentence of (a) : it is related to fuel flow (this is also the title of paragraph 955). The remaining part of (a) is simply a means of	3.1 Not agreed. JAR 25J955 requires all APUs to show correct fuel flow and fuel pressure during intended operations. Essential APUs must furthermore show correct fuel flow and pressure during defined fuel tank levels and equipment failure conditions.

compliance. For an essential APU, (1) and (2) would be applicable. Therefore, for an essential APU, if the fuel pressure is OK (955 (a)(1)) and if the tank contains enough fuel (955 (a)(2)(i)), then there is no need to demonstrate that the fuel flow is OK. This is very curious. 3.2 Furthermore, the text of (i) is extremely difficult to understand. Let us try to translate it into something simpler. The quantity "necessary to show compliance with this section" is equal to zero because there is no requirement at all on fuel quantity in this 955 (fuel flow is the subject). Then, the "quantity of fuel in the tank" must be lower than the unusable quantity : this is not very "usable" !!	3.2 Not agreed. Some fuel (quantity) is needed to have any capability for fuel flow. This defines the allowable fuel quantity.
JAR 25J955(a)(2)(ii) 3.1 The requirement is far from being clear. It appears as imposing at same time to use the main pumps and not to use the main pumps (by substituting the emergency pumps to the main pumps) ! This is very curious. 3.2 Furthermore, the wording "each operating condition and attitude for which compliance with this section is shown" is not related to the only existing requirement in 955 (in (a)) which refers to "each intended operating condition and manoeuvre". What does this mean ? 3.3 If we consider the fuel flow requirement of 955 (a), it is possible that the pumps might have a role in this demonstration. But, does this means that the pumps must be considered for	3.1 Not agreed. These words have been used to require compliance to be shown with the 'main pumps to be used as necessary' and with the 'emergency pumps used as a substitute'. Note: Substitute means 'instead of', not 'as well as'. 3.2 Agreed. Consistency could be better. PPSG will consider for its Work Programme. 3.3 Not agreed. For non-essential APUs, the fuel flow requirement can be met without pumps. Or with pumps. Or by any other means. The requirement is not prescriptive.

essential APUs and not for non-essential APUs ? Does this mean that the fuel flow must be ensured without any pump for non-essential APUs ?	
JAR 25J955(a)(2)(iii) 3.1 Is there a requirement imposing a by-pass of the fuel flow meter ? None was identified in this NPA. 3.2 If there is no mandatory by-pass and if the fuel cannot flow through the blocked meter, what is really the requirement ? The only identified requirement in 955 (a) only (implicitly) refers to normal operations. A blocked meter would probably be considered as a failure condition. 3.3 If we consider the fuel flow requirement of 955 (a), why is this requirement limited to essential APUs ? Are we less severe for essential APUs than for non-essential APUs ?	3.1 No. 3.2 The requirement is that fuel must flow … 3.3 The corresponding, but un-written, requirement for non-essential APUs would be: "If there is a fuel flowmeter, it must be blocked and fuel is not required to flow through the meter or its bypass.'.
JAR 25J997(d) 3.1 The new APU text, which is very similar to 6.6, is the following JAR-APU 250 FUEL SYSTEM (a) The fuel specification, rate, pressure and temperature range of fuel flow to the inlet of the APU fuel system and the degree of filtration necessary for satisfactory unit functioning must be established and listed in the APU instructions for installation. 3.2 Instead of making reference to a JAR-APU paragraph, it is suggested to make reference to the instructions for installation. This would be more general and consistent with normal practice. The following is proposed : "… established for the APU in its	3.1 Agreed. The JAA will be recommended to use the appropriate reference (JAR-APU 250) in JAR25J997(d). 3.2 Not agreed. The direct reference to the JAR-APU requirement is considered helpful.

installation instructions".	
JAR 25J1011(b) There is no "approved" maximum allowable oil consumption of the APU. This is not a requirement in JAR-APU and no such requirement was identified in this NPA. It is suggested to delete the word "approved".	Agreed. JAA will be recommended to delete the word 'approved' from JAR 25J1011(b).
JAR 25J1023 Why is there a sub-paragraph (a) ? Apparently this is not the policy used in this NPA (see, for example, paragraphs 1019 or 1041) It is suggested to delete the numbering "(a)".	The proposed Subpart J carries on a 20 year tradition of using, where possible, the equivalent section numbering as in Subpart E.
JAR 25 J1091(c), (d) and (e) How should these paragraphs be interpreted in case of ingestion of flammable de-icing fluid through the APU air inlet ?	Noted. The subject of de-icing fluid ingestion is not anticipated by Subpart J. The subject will be raised as a possible PPSG work item.
JAR 25J1121(f) How is defined an "excessively high temperature" ? It is impossible to interpret this requirement because there is no criteria for judging the level of temperature. This paragraph should be improved to provide a clear criteria.	Exceeding a temperature limit would be considered to be an excessively high temperature.
JAR 25J1141(c) The text is "the APU must provide means to automatically shut down the APU". This does not sound logical. Is the intent to say "the APU installation must….", to be consistent with 901 ?	Agreed. JAA will be recommended to revise JAR 25J1141(c) as follows: "(c) For unattended operation, the APU installation must: …"

JAR 25J1141(c)(1)(i) 3.1 The new text in TSO C77 b and JAR-APU is the following for essential APUs JAR-APU 530 AUTOMATIC SHUTDOWN If automatic features are provided, provision must be made to limit automatic shutdowns in flight to those failure occurrences which could result in a potentially hazardous condition. This does not seem to be consistent with the proposed JAR-25 requirement. It is suggested to use this "APU" text to improve the JAR-25 requirements. It was considered that an essential APU should be kept running as long as possible. 3.2 The justification ("requires protection by auto-shut down from a detectable hazardous operating condition") is not consistent with the proposed rule : an exceedence of an APU operating limitation is not hazardous. 3.3 It should be noted that the word "exceedence" is not referenced in any known dictionary. Therefore, in the FAA/JAA harmonisation process for engines, it was agreed to use the spelling "exceedence". It is recommended to use the same spelling in JAR-25.	3.1 Not agreed. JAR 25J1141(c)(1)(i) does not relate to essential or non-essential APUs. There is no concern about unintended shut down on the ground. If a limit is reached, automatic shut-down is needed. 3.2 Not agreed. Exceeding a limit could lead to a hazard. 3.3 MS spell check has it (the use of the word 'exceedence'). But, JAA please note correct spelling.
JAR 25J1183(a) 3.1 The wording is awkward. We find "except" at the beginning, "except" in the middle, "unless" later on in this paragraph (a). This does not comply with the guidance found in the FAA "Plain English guide".	3.1 Not agreed. 3.2 Not agreed. For JAR-25, we require all flammable fluid containing tanks, in the APU compartment, to be Fireproof, not just those which are "part of and attached to the APU". 3.3 Not agreed.

3.2 The new text in JAR-APU is the following (b) Except as provided by JAR-APU 220 (c), each external line, fitting and other component which contains or conveys flammable fluids during normal APU operation, must be at least Fire Resistant. Components must be shielded or located to safeguard against ignition of leaking flammable fluid. (c) Tanks which contain flammable fluid and any associated shut-off means and supports, which are part of and attached to the APU, must be Fireproof either by construction or by protection, unless damage by fire will not cause leakage or spillage of a hazardous quantity of flammable fluid. Note that the wording "during normal APU operation" is intended to avoid vent and drain lines which do not contain flammable fluid in normal operation. 3.3 It is suggested that JAR-25 might benefit from this "improved" format.	
JAR 25J1183(b)(1) 3.1 It is abnormal to exempt some parts from this basic requirement simply because they are incorporated into the APU design. This requirement is valid for all flammable fluid carrying components. 3.2 Furthermore, (a) is applicable to lines, fittings and other components. The exemption clause of (b)(1) is only applicable to lines and fittings. Why are the other components not exempted ? 3.3 It is then suggested to delete this (b)(1). There is no risk at all for interference between APU and aircraft certification	3.1 Not agreed. This principle has been used for many years. 3.2 Noted. The answer to the commentor's question is not known. But the current Subpart J requirement provides the safety objective. 3.3 Not agreed. Deletion of JAR 25J1183(b)(1) would lead to additional Compliance burden, without safety improvement.

activities : the requirements are the same and the APU designer will deal with APU parts under JAR-APU when the aircraft designer will deal with aircraft parts under JAR-25.	
JAR 25J1187(a)(2) Consistency of this text (fuel discharge) with JAR-34 on prevention of fuel venting should be checked.	Noted. There is no conflict with proposals for JAR-34.
JAR 25J1203(g) It is curious to see that compliance with JAR-25 is kept hostage of a criteria found in a document which is out of control. Furthermore the alternative “acceptable equivalent” is totally undefined. The text should be modified so that the pass / fail criteria is clearly spelled out in JAR-25.	Noted. JAA will be recommended to revise this JAR 25J1203(g) to read: “… using the response time criteria specified in JTSO-2C11e or an acceptable equivalent, for the detector.”.
JAR 25J1305(a) 3.1 “Exceedance” in (a)(3) should be spelled out as “exceedence” (see another comment). 3.2 It should be noted that the new JAR-APU text is as follows JAR-APU 100 PROVISIONS FOR INSTRUMENTS (a) The APU must have provisions for providing a signal for any instrumentation necessary to ensure continued safe operation of the APU and that established APU limits are not exceeded. (b) Instrumentation provisions per JAR-APU 100 (a) need not be provided if automatic features of the APU and its instructions for installation provide a degree of safety equal to	3.1 Noted. JAA please note. 3.2 Noted. Proposed text provides the necessary safety objectives for the aeroplane.

that intended by compliance with JAR-APU 100 (a). The last part of APU 100 (b) was intended to clarify the meaning of the proposed text on parameter display. May be, this could be considered for clarification of JAR-25 text as well.	
There is no **25J1337(a), (b) or (c)** : where are they ? There is no **25J1501(a)** : where is it ? There is a "**25J1557(b)**" without a "(a) and there is a "(2)" without a "(1)". Where are the missing sub-paragraphs ?	The proposed Subpart J carries on a 20 year tradition of using, where possible, the equivalent section numbering as in Subpart E.
JAR 25J943 and ACJ 25J943 3.1 The text of 25J943 refers to the "APU". According to 25J901, this is only the thing which is "certified" under JAR-APU. Therefore, the "hazardous malfunction" of the APU can only be related to JAR-APU 210 which defines the Hazardous APU Effects as follows : JAR-APU 210 SAFETY ANALYSIS It must be shown by analysis that any malfunction or any single or multiple failure leading to any of the following Hazardous APU Effects are not expected to occur at a rate in excess of that defined as Extremely Remote : (a) Uncontrolled fire; (b) Burst (release of hazardous fragments through the APU case); (c) Loads greater than those ultimate loads specified in JAR-APU 130 ; (d) Loss of the capability of being shut down; or (e) An unacceptable concentration of toxic products in bleed air. (f) Axial ejection of substantially whole rotors retaining high energy.	3.1 Comment not found. 3.2 With the APU operating in the essential role, a single failure could leave the APU as the only provider of generated electrical power. In this case, the APU must keep running throughout all anticipated operating conditions, including negative g.

3.2 The paragraph 2 of ACJ 25J943 implies that an inadvertent shut down for an essential APU would not be acceptable. If this is the right interpretation of the ACJ, then this would not be consistent with the rule (see 3.1 above where a shut down is not hazardous).	
ACJ 25j901(c)(2) 3.1 The text of 25J901 (c)(2) does not refer to assembly of components. 3.2 JAR 25.671 (b) is not applicable unless it is justified that the APU is a "flight control system". This is very unlikely, especially for non-essential APUs. 3.3 Therefore, this ACJ represents rulemaking by advisory material and should be changed into a new requirement in sub-part J.	The requirement is 'that the components must be constructed, arranged and installed (i.e. assembled) …'. The advisory material is that the means, identified in JAR 25.671(b) for preventing incorrect assembly can be an acceptable means of compliance. There is no implication that the APU will be a part of the flight control system.
.**ACJ 25J901 (c)(4)** : The reference to the engine is surprising. Why is there a "requirement" on the engine because of the APU ?	Noted. This 'surprise' has existed for 20 years.
ACJ 25J943 : the ACJ introduces an exemption to the rule : 25J943 requires consideration of the greatest duration expected. This ACJ limits the applicability of the rule by imposing consideration of an arbitrary value of 5 seconds. The rule and the ACJ should be made compatible.	Not agreed. The ACJ conditions are accepted, providing there are no greater negative g durations expected.
ACJ 25J955 (a)(4) : this "definition" should be moved into the rule. This is not an obvious interpretation of the rule and therefore it is rulemaking by advisory material.	Not agreed. This interpretation has been in use for many years.

ACJ 25J1093 (b)(2) paragraph 2.2 : This reference is incorrect : there is no paragraph 5.2 in section 1 in the previous text of JAR-APU. The paragraph 5.2 in appendix 1 is not related to icing ("accessibility"). It is then difficult to identify the adequate reference. This might be paragraph 6.4.1 in appendix 1 which is related to the same subject. It is suggested that the new appropriate reference might be JAR-APU 510 which reads as follows JAR-APU 510 ICE PROTECTION (a) The APU must be designed and constructed to prevent the accumulation of ice in quantities sufficient to cause a substantial loss of APU power or shutdown during operation throughout its operating range within the icing envelopes specified in JAR-1. (b) Operation of the APU under the conditions of JAR-APU 510 (a) must be substantiated by test, analysis or combination thereof. Any limitations for operation must be documented in the APU instructions for installation.	Noted. The JAA will be recommended to use the appropriate reference (JAR-APU 510) The proposed revision is not supported.
JAR 25J903(e)(2) : JAA should add / inform the "cold soak" criteria to be followed during the in-flight start capability compliance demonstration for essential APU's.	Noted. This proposal (APU cold soak guidance) could be considered for future work, although it should be relatively easy to consider what starting requirements may be required for essential APUs and to test for those. If there is any doubt about the capability of restarting, the APU should be running before the flight departs.
Proposed text **JAR 25J1201(b)** "Each fire extinguishing system in an APU compartment must be fireproof.	Not agreed. The wording used is unchanged and is the same as for the engine.
Proposed text **JAR 25J1549** : "For each APU instrument either a placard or colour makings or display colour changes or an	Not agreed. AMJ 25-11 Electronic Display Systems has been the means by which the JAA provides guidance on these types of display.

acceptable combination…”. Proposed text **JAR 25J1549(a)** : “Each maximum and, if applicable, minimum safe operating limit must be marked with a red radial or a red line or red display digits”. Proposed text **JAR 25J1549(b)** : “Each normal operating range must be marked with a green arc or green display digits, not exceeding beyond the maximum and minimum safe limits”. Proposed text **JAR 25J1549(c)** : “Each precautionary operating range must be marked with a yellow arc or a yellow line or yellow display digits”. Proposed text **JAR 25J1549(d)** : “Each APU speed range that is restricted because of excessive vibration stresses must be marked with red arcs od red display digits”.	Note that this document is being revised at the moment (Sep 02)
It is noted that in some of the proposed requirements of this subpart J, there is no sub-paragraph (b). If these sub-paragraphs are reserved, it would be normal practice to state, “(b) Reserved.”. (Examples include 25J903, and 25J939) Also, 25J1121 appears to have sub-paragraph (e) missing, 25J1337 starts at sub-paragraph (d), and 25J1501 and 1557 both start at sub-paragraph (b).	See Response to 009, 3.3. The use of ‘Reserved’ would result in the addition of many unnecessary lines.
It is noted that NPA 25E-304 modifies **JAR 25A994**, by making cross reference to a modified JAR 25.721(b). NPA 25J-300 will have to take account of this in the finally published JAR 25J994.	Agreed. If NPA 25E-304 is introduced, JAA are recommended to revise JAR 25 J994 to read: “… on a paved runway, under each of the conditions prescribed in JAR 25.721(b).”.
In **25J1091**, it is recommended that a future rulemaking activity should address the need to prevent any de-icing fluid used to de-ice the aircraft on the ground from entering the APU inlet.	Noted. The subject of de-icing fluid ingestion is not anticipated by Subpart J. The subject will be raised as a possible PPSG work item.

Recent service experience has shown this to cause hazardous effects.	

II-A. EXPLANATORY NOTE JAA NPA 25E-342

Originally JAA NPA 25E-342, Revised Fuel Tank Ignition Prevention Requirements for Large Aeroplanes

The text of the JAA NPA 25E-342 was developed as well by the JAA-PPSG. This latter activity was not included in the Harmonisation Work Programme but the adoption of the NPA will assure harmonisation with the corresponding FAR 25 requirements

JAA NPA 25E-342 was adopted by the JAAC on 12 September 2003 under a written procedure.

II-B. PROPOSALS TRANSPOSED JAA NPA 25E-342

The following amendments should be included in Decision No. 2003/2/RM of the Executive Director of the Agency of 17 October 2003:

A- Replace the current paragraph CS 25.981 with a new paragraph CS 25.981

B- Introduce a new AMC to CS 25.981(a)

C- Introduce a new AMC to CS 25.981(c)

BOOK 1 **CS - 25**

CS 25.981 Fuel tank ignition prevention.

(a) No ignition source may be present at each point in the fuel tank or fuel tank system where catastrophic failure could occur due to ignition of fuel or vapours. This must be shown by:
  - (1) Determining the highest temperature allowing a safe margin below the lowest expected auto-ignition temperature of the fuel in the fuel tanks.
  - (2) Demonstrating that no temperature at each place inside each fuel tank where fuel ignition is possible will exceed the temperature determined under paragraph (a)(1) of this section. This must be verified under all probable operating, failure, and malfunction conditions of each component whose operation, failure, or malfunction could increase the temperature inside the tank.
  - (3) Demonstrating that an ignition source does not result from each single failure and from all combinations of failures not shown to be Extremely Improbable as per 25.1309. (See AMC 25.981(a))

(b) Reserved.

(c) Design precautions must be taken to achieve conditions within the fuel tanks which reduce the likelihood of flammable vapours. (See AMC 25.981(c)).”

BOOK 2 **CS - 25**

AMC 25.981(a)
Ignition precautions

1- Introduction

Service history has shown that ignition sources have developed in aircraft fuel tanks due to unforeseen failure modes or factors that may not have been considered at the time of original certification of the aircraft.

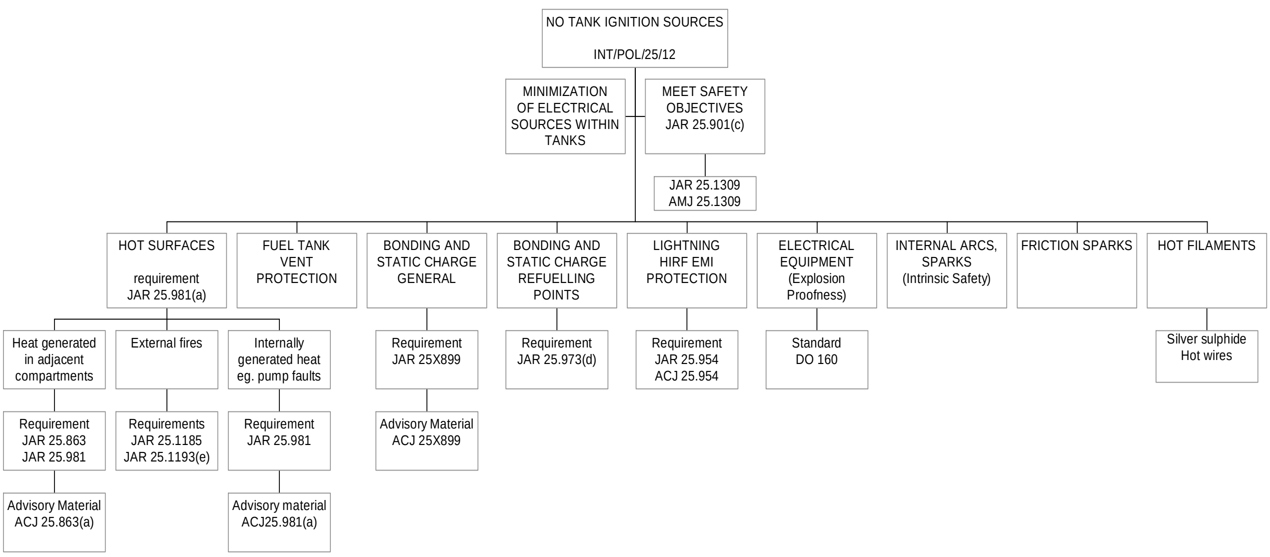
2- Background

There are three primary phenomena that can result in ignition of fuel vapours in aeroplane fuel tanks. The first is electrical arcs. The second is friction sparks resulting from mechanical contact of rotating equipment in the fuel tank. The third is hot surface ignition or auto ignition.

The conditions required to ignite fuel vapours from these ignition sources vary with pressures and temperatures within the fuel tank and can be affected by sloshing or spraying of fuel in the tank. Due to the difficulty in predicting fuel tank flammability and eliminating flammable vapours from the fuel tank, design practices have assumed that a flammable fuel air mixture exists in aircraft fuel tanks and require that no ignition sources be present.

Any components located in or adjacent to a fuel tank must be qualified to meet standards that assure, during both normal and failure conditions, ignition of flammable fluid vapours will not occur. This is typically done by a combination of design standards, component testing and analysis. Testing of components to meet explosion proof requirements is carried out for various single and combinations of failures to show that arcing, sparking, auto ignition or flame propagation from the component will not occur. Testing for components has been accomplished using standards and component qualification tests. The standards include for example Eurocae ED-14 / RTCA DO160 and BS 3G 100 that defines explosion proof requirements for electrical equipment and analysis of potential electrical arc and friction sparks.

FUEL SYSTEM IGNITION PREVENTION



Therefore the focus of this evaluation of the aircraft fuel system should be to identify and address potential sources of ignition within fuel tanks, which may not previously have been considered to be unsafe features.

3- Ignition Sources

3.1 Electrical Arcs and Sparks

Ignition sources from electrical arcs can occur as a result of electrical component and wiring failures, direct and indirect effects of lightning, HIRF / EMI, and static discharges.

The level of electrical energy necessary to ignite fuel vapours is defined in various standards. The generally accepted value is 0.2 millijoules. An adequate margin needs to be considered, when evaluating the maximum allowable energy level for the fuel tank design.

3.2 Friction Sparks

Rubbing of metallic surfaces can create friction spark ignition sources. Typically this may result from debris contacting a fuel pump impeller or an impeller contacting the pump casing.

3.3 Hot Surface Ignition

Guidance provided in AC 25-8 has defined hot surfaces which come within 30 degrees Centigrade of the autogenous ignition temperature of the fuel air mixture for the fluid as ignition sources. It has been accepted that this margin of 30 degrees Centigrade supported compliance to CS 25.981(a). Surface temperatures not exceeding 200^{o} C have been accepted without further substantiation against current fuel types.

4- Lessons learned

4.1 Introduction

As detailed above, the fuel system criticality may not have been addressed in the past against current understanding as far as the ignition risk is concerned. Inspections and design review have been performed, resulting in findings detailed below. One of the main lessons learned is to minimize electrical sources within fuel tanks (see § 4.3).

4.2 Components in-service experience

The following sections intend to present a list of faults, which have occurred to fuel system components. By its nature it cannot be an exhaustive list, but is only attempting to provide a list of undesirable features of fuel system components that should be avoided when designing fuel tanks.

Pumps

a) Pump inducer failures have occurred resulting in ingestion of the inducer into the pump impeller and release of debris into the fuel tank.
b) Pump inlet check valves have failed resulting in rubbing on pump impeller.
c) Stator windings have failed during operation of the fuel pump. Subsequent failure of a second phase of the pump caused arcing through the fuel pump housing.
d) Thermal protective features incorporated into the windings of pumps have been deactivated by inappropriate wrapping of the windings.
e) Cooling port tubes have been omitted during pump overhaul.
f) Extended dry running of fuel pumps in empty fuel tanks, violation of manufacturers recommended procedures, suspected of being causal factors in two incidents.
g) Use of steel impellers which might produce sparks if debris enters the pump.
h) Debris has been found lodged inside pumps.
I) Pump power supply connectors have corroded allowing fuel leakage and electrical arcing.
j) Electrical connections within the pump housing have been exposed and designed with inadequate clearance from the pump cover resulting in arcing.
k) Resettable thermal switches resetting at higher trip temperature.
l) Flame arrestors falling out of their respective mounting.
m) Internal wires coming in contact with the pump rotating group, energising the rotor and arcing at the impeller / adapter interface.
n) Poor bonding across component interfaces.
o) Insufficient ground fault current capability.
p) Poor bonding of components to structure.
q) Loads from the aeroplane fuel feed plumbing were transferred.
r) Premature failure of fuel pump thrust bearings allowing steel rotating parts to contact the steel pump side plate.

Wiring to Pumps located in metallic conduits or adjacent to fuel tank walls.

Wear of Teflon sleeves and wiring insulation allowing arcing to conduit causing an ignition source in tank, or arcing to the tank wall.

Fuel Pump Connectors

Electrical arcing at connections within electrical connectors has occurred due to bent pins or corrosion.

FQIS Wiring

Degradation of wire insulation (cracking) and corrosion (copper sulphate deposits) at electrical connectors, unshielded FQIS wires have been routed in wire bundles with high voltage wires.

FQIS Probes

Corrosion and copper sulphide deposits have caused reduced breakdown voltage in FQIS wiring, FQIS wiring clamping features at electrical connections on fuel probes has caused damage to wiring and reduced breakdown voltage. Contamination in the fuel tanks including: steel wool, lock wire, nuts, rivets, bolts; and mechanical impact damage, caused reduced arc path between FQIS probe walls.

Bonding Straps
Corrosion, inappropriately attached connections (loose or improperly grounded attachment points). Static bonds on fuel system plumbing connections inside the fuel tank have been found corroded or mechanically worn.

Failed or aged seals
Seal deterioration may result in leak internal or external to fuel system, as well as fuel spraying.

4.3 Minimising electrical components hazards within fuel tanks

One of the lessons learned listed above is the undesirable presence of electrical components within fuel tanks. Power wiring has been routed in conduits when crossing fuel tanks, however, chaffing has occurred within conduits. It is therefore suggested that such wiring should be routed outside of fuel tanks to the maximum extent possible. At the equipment level, connectors and adjacent areas should be taken into account during the explosion proofness qualification of the equipment (typically, pumps).
However, for some wiring, such as FQIS or sensor wiring, it might be unavoidable to route them inside of tanks, and therefore they should be qualified as intrinsically safe. The Safety Assessment section below indicates how any residual fuel tank wiring may be shown to meet the required Safety Objectives.

5- Safety assessment

5.1 Introduction

The fuel system must comply with CS 25.901(c), which requires compliance to CS 25.1309. According to CS 25.981(a)(3), a Safety Assessment of the fuel system should be performed showing that the presence of an ignition source within the fuel system is Extremely Improbable and does not result from a single failure, as per CS 25.1309 and the corresponding AMC 25.1309 principles.

The Acceptable means of Compliance (AMC) 25.1309, “System Design and Analysis” describes methods for completing system safety assessments (SSA). The depth and scope of an acceptable SSA depends upon the complexity and criticality of the functions performed by the system under consideration, the severity of related failure conditions, the uniqueness of the design and extent of relevant service experience, the number and complexity of the identified causal failure scenarios, and the ability to detect contributing failures. The SSA criteria, process, analysis methods, validation and documentation should be consistent with the guidance material contained in AMC 25.1309.

Failure rates of fuel system component should be carefully established as required using in-service experience to the maximum extent.

5.2 Assumptions and Boundary Conditions for the Analysis:

The analysis should be conducted based upon assumptions described in this section.

5.2.a Fuel Tank Flammability

The system safety analysis should be prepared considering all aircraft flight and ground conditions, assuming that an explosive fuel air mixture is present in the fuel tanks at all times.

5.2.b Failure Condition Classification

Unless design features are incorporated that mitigate the hazards resulting from a fuel tank ignition event, (e.g. polyurethane foam), the SSA should assume that the presence of an ignition source is a catastrophic failure condition.

5.2.c Failure conditions

The analysis should be conducted assuming deficiencies and anomalies, failure modes identified by the review of service information on other products as far as practical, and any other failure modes identified by the fuel tank system functional hazard assessment. The effects of manufacturing variability, ageing, wear, corrosion, and likely damage should be considered.

In service and production functional tests, component acceptance tests and maintenance checks may be used to substantiate the degree to which these states must be considered. In some cases, for example component bonding or ground paths, a degraded state will not be detectable without periodic functional test of the feature. For these features, inspection/test intervals should be established based on previous service experience on equipment installed in the same environment. If previous experience on similar or identical components is not available, shorter initial inspection/test intervals should be established until design maturity can be assured.

Fuel Pumps.

Service experience shows that there have been a significant number of failure modes, which have the capability of creating an ignition source within the tank. Many of these are as the result of single failures, or single failures in combination with latent failures. It should be shown that fuel pumps do not run dry beyond their qualified level. If fuel pumps can be uncovered during normal operation, it is recommended that pumps are shut down automatically and that the shutdown feature is sufficiently robust such that erroneous pump running does not cause a hazard. It is also recommended to consider the inlet design such that the ingestion of FOD is minimized. It is acceptable to uncover pumps when operating under negative "g" conditions.

Fuel Pump Wiring.

Despite precautions to prevent fuel pump wire chafing, arc faults have occurred. For pump wire installations within the tank or adjacent to the tank wall to remain acceptable, additional means must be provided to isolate the electrical supply, in the event of arc faults. The means must be effective in preventing continued arcing to the conduit or the tank wall.

FQIS Wiring.

Although in recent times, constructors have made attempts to segregate FQIS wiring from other aircraft wiring, it is recognised that it is not possible to be confident, at the design stage, that the segregation will remain effective over the whole fleet life. Subsequent aircraft modifications in service may negate the design intentions. To counter this threat to FQIS wiring, additional design precautions should be considered to prevent any unwanted stray currents, from entering the tank. The precautions taken must remain effective, even following anticipated future modifications.

Bonding Schemes.

Service experience has shown that the required Safety Objectives can be met with a redundant bonding scheme incorporating dual electrical paths, with appropriate level of inspection. No definitive advice can be given about the inspection period, but it is expected that the design and qualification of the bonding leads and attachments (or alternative bonding means) will be sufficiently robust, so that frequent inspections will not be needed.

5.2.d External Environment

The severity of the external environmental conditions that should be considered are those established by certification regulations and special conditions (e.g., HIRF, lightning), regardless of the associated probability. For example, the probability of lightning encounter should be assumed to be one.

5.3 Qualitative Safety Assessment

The level of analysis required to show ignition sources will not develop will depend upon the specific design features of the fuel tank system being evaluated. Detailed quantitative analysis should not be necessary if a qualitative safety assessment shows that features incorporated into the fuel tank system design protect against the development of ignition sources within the fuel tank system. For example, if all wiring entering the fuel tanks was shown to have protective features such as separation, shielding or surge suppressors, the compliance demonstration would be limited to demonstrating the effectiveness of the features and defining any long term maintenance requirements so that the protective features are not degraded.

5.4 Component Qualification Review

Qualification of components such as fuel pumps, using the standard specifications has not always accounted for unforeseen failures, wear, or inappropriate overhaul or maintenance. Service experience indicates that the explosion proofness demonstration needs to remain effective under all of the continued operating conditions likely to be encountered in service. Therefore an extensive evaluation of the qualification of components may be required if qualitative assessment does not limit the component as a potential ignition source.

5.5 Electrical sparks

A failure analysis should be performed of all fuel systems and sub systems with wiring routed into fuel tanks. Systems that should be considered include, temperature indication, Fuel Quantity Indication System, Fuel Level sensors, fuel pump power and control and indication, and any other wiring routed into or adjacent to fuel tanks. The analysis must consider system level failures and also component level failures mentioned in Section 4.2 and discussed below. Component failures, which have been experienced in service, are to be considered as probable, single failures. The analysis should include existence of latent failures, such as contamination, damage/pinching of wires during installation or corrosion on the probes, connectors, or wiring and subsequent failures that may lead to an ignition source within the fuel tank. The wire routing, shielding and segregation outside the fuel tanks should also be considered. The evaluation must consider both electrical arcing and localised heating that may result on equipment, fuel quantity indicating system probes, and wiring.

5.5.a Electrical Short Circuits

5.5.a.1 Effects of electrical short circuits, including hot shorts, on equipment and wiring which enter the fuel tanks should be considered, particularly for the fuel quantity indicating system wiring, fuel level sensors and probes.

5.5.a.2 The evaluation of electrical short circuits must consider shorts within electrical equipment.

5.5.b Electromagnetic Effects, including Lightning, EMI, and HIRF

5.5.b.1 Effects of electrical transients from lightning, EMI or HIRF on equipment and wiring within the fuel tanks should be considered, particularly for the fuel quantity indicating system wiring and probes.

5.5.b.2 Latent failures such as shield and termination corrosion, shield damage, and transient limiting device failure should be considered and appropriate indication or inspection intervals established.

5.5.b.3 The evaluation of electromagnetic effects from lightning, EMI, or HIRF must be based on the specific electromagnetic environment of a particular aircraft model. Standardized tests such as those in EUROCAE ED-14/RTCA DO-160 Sections 19, 20 and 22 are not sufficient alone, without evaluation of the characteristics of the specific electromagnetic environment for a particular aircraft model to show that appropriate standardised ED-14/DO-160 test procedures and test levels are selected. Simulation of various latent failures of fuel system components within the tanks may be required to demonstrate the transient protection effectiveness.

5.6 Friction Sparks:

The analysis should include evaluation of the effects of debris entering the fuel pumps, including any debris that could be generated internally such as any components upstream of the pump inlet. Service experience has shown that pump inlet check valves, inducers, nuts, bolts, rivets, fasteners, sealant, lock wire etc. have been induced into fuel pumps and contacted the impeller. This condition could result in creation of friction sparks and should be considered as part of the system assessment when conducting the system safety assessment.

6- Instructions for continued airworthiness for the fuel tank system

The analysis conducted to show compliance with CS 25.981(a) may result in the need to define certain required inspection or maintenance items. Any item that is required to assure that an ignition source does not develop within the fuel tank or maintain protective features incorporated to preclude a catastrophic fuel tank ignition event must be incorporated in the limitations section of the instructions for continued airworthiness or in the maintenance program.

AMC 25.981(c)
Flammability precautions
See CS 25.981(c)

The intention of this requirement is to introduce design precautions, to avoid unnecessary increases in fuel tank flammability. These precautions should ensure :

(i) no large net heat sources going into the tank,
(ii) no unnecessary spraying, sloshing or creation of fuel mist.
(iii) reserved.

II-C. ORIGINAL JAA NPA PROPOSALS JUSTIFICATION

1. Summary

Following the accident to Flight TWA 800, the influences on fuel tank safety have been widely discussed in recent years, to establish means by which fuel tank explosions can be prevented in the future.

Effective June 6, 2001, the FAA has issued a set of new rules related to fuel tank safety, including SFAR No. 88 and amendments to 14 CFR Parts 21, 25, 91, 121, 125 and 129. Amendment 25-102 sets new fuel tank safety requirements for type certifications requested after June 6, 2001.

The purpose of this NPA is to introduce into JAR-25 the equivalent of FAR 25 Amendment 102, taking into account the JAA comments provided on the FAA proposed rulemaking action.

2. Background

On July 17, 1996, a 25-year old Boeing Model 747-100 series aeroplane was involved in an in-flight break-up after takeoff from Kennedy International Airport in New York, resulting in 230 fatalities. The accident investigation conducted by the National Transportation Safety Board (NTSB) indicated that the centre wing fuel tank exploded due to an unknown ignition source. The NTSB issued recommendations intended to:

- reduce heating of the fuel in the centre wing fuel tanks on the existing fleet of transport aeroplanes,
- reduce or eliminate operation with flammable vapours in the fuel tanks of new type certificated aeroplanes, and
- re-evaluate the fuel system design and maintenance practices on the fleet of transport aeroplanes.

The accident investigation focused on mechanical failure as providing the energy source that ignited the fuel vapours inside the tank.

The NTSB announced their official findings of the TWA 800 accident at a public meeting held August 22-23, 2000, in Washington D.C. The NTSB determined that the probable cause of the explosion was ignition of the flammable fuel/air mixture in the centre wing fuel tank. Although the ignition source could not be determined with certainty, the NTSB determined that the most likely source was a short circuit outside of the centre wing tank that allowed excessive voltage to enter the tank through electrical wiring associated with the fuel quantity indication system (FQIS). Opening remarks at the hearing also indicated that : "…This investigation and several others have brought to light some broader issues regarding aircraft certification. For example, there are questions about the adequacy of the risk analyses that are used as the basis for demonstrating compliance with many certification requirements."

This accident prompted the FAA and the JAA to examine the underlying safety issues surrounding fuel tank explosions, the adequacy of the existing regulations, the service history of aeroplanes certificated to these regulations, and existing maintenance practices relative to the fuel tank system.

The flammability characteristics of the various fuels approved for use in transport aeroplanes results in the presence of flammable vapours in the vapour space of fuel tanks at various times during the operation of the aeroplane. Vapours from Jet A fuel (the typical commercial turbojet engine fuel) at temperatures below approximately 38°C are too lean to be flammable at sea level; at higher altitudes the fuel vapours become flammable at temperatures above approximately 7°C (at 40,000 feet altitude).

However, the regulatory authorities and aviation industry have always presumed that a flammable fuel air mixture exists in the fuel tanks at all times and have adopted the philosophy that the best way to ensure aeroplane fuel tank safety is to preclude ignition sources within fuel tanks. This philosophy has been based on the application of fail-safe design requirements to the aeroplane fuel tank system to preclude ignition sources from being present in fuel tanks when component failures, malfunctions, or lightning encounters occur.

Possible ignition sources that have been considered include:

- electrical arcs,
- friction sparks, and
- autoignition. (The autoignition temperature is the temperature at which the fuel/air mixture will spontaneously ignite due to heat in the absence of an ignition source.)

Some events that could produce sufficient electrical energy to create an arc include:

- lightning,
- electrostatic charging,
- electromagnetic interference (EMI), or
- failures in aeroplane systems or wiring that introduce high-power electrical energy into the fuel tank system.

Friction sparks may be caused by mechanical contact between certain rotating components in the fuel tank, such as a steel fuel pump impeller rubbing on the pump inlet check valve. Autoignition of fuel vapours may be caused by failure of components within the fuel tank, or external components, systems, or events that cause components or tank surfaces to reach a high enough temperature to ignite the fuel vapours in the fuel tank.

3. Existing Regulations/Certification Methods

The current JAR-25 regulations that are intended to require designs that preclude the presence of ignition sources within the aeroplane fuel tanks are as follows:

JAR 25.901(c) and 25.1309 provide aeroplane system fail-safe requirements. Compliance with JAR 25.1309 requires an analysis, and testing where appropriate, considering possible modes of failure, including malfunctions and damage from external sources, the probability of multiple failures and undetected failures, the resulting effects on the aeroplane and occupants, considering the stage of flight and operating conditions, and the crew warning cues, corrective action required, and the capability of detecting faults.

This provision has the effect of mandating the use of “fail-safe” design methods, which require that the effect of failures and combinations of failures be considered in defining a safe design. Detailed methods of compliance with JAR 25.1309 are described in AMJ 25.1309 and are intended as a means to evaluate the overall risk, on average, of an event occurring within a fleet of aircraft.

<u>JAR 25.954</u> requires that the fuel tank system be designed and arranged to prevent the ignition of fuel vapour within the system due to the effects of lightning strikes. Compliance with this regulation is typically shown by incorporation of design features such as minimum fuel tank skin thickness, location of vent outlets out of likely lightning strike areas, and bonding of fuel tank system structure and components. Guidance for demonstrating compliance with this regulation is provided by ACJ 25.954, which is referring to FAA AC 20-53A, “Protection of Aircraft Fuel Systems Against Fuel Vapour Ignition Due to Lightning.”

<u>JAR 25.981</u> requires that the applicant determine the highest temperature allowable in fuel tanks that provides a safe margin below the lowest expected autoignition temperature of the fuel that is approved for use in the fuel tanks. No temperature at any place inside any fuel tank where fuel ignition is possible may then exceed that maximum allowable temperature. This must be shown under all probable operating, failure, and malfunction conditions of any component whose operation, failure, or malfunction could increase the temperature inside the tank. Manufacturers have demonstrated compliance with this regulation by testing and analysis of components to show that design features, such as thermal fuses in fuel pump motors, preclude an ignition source in the fuel tank when failures such as a seized fuel pump rotor occur.

<u>INT/POL/25/12</u> : On 1st of October 2000, the JAA issued an Interim Policy on the subject of Fuel Tank Safety. An Interim Policy is used by JAA in circumstances where Special Conditions need to be established so as to ensure a consistent approach across the range of JAA Certification and Validation projects. This Interim Policy confirms that, for new Certification and Validation Projects, a Safety Assessment must be made of the ignition source probability, using the assessment methods of JAR 25.901(c) and JAR 25.1309. If this NPA is adopted, the Interim Policy will no longer be needed.

<u>4. Discussion of the proposals</u>

4.1 Design and Service History Review

Service history of transport aeroplanes has been examined, and an analysis of the history of fuel tank explosions on these aeroplanes was performed. While there was a significant number of fuel tank fires and explosions that occurred during the 1960’s and 1970’s on several aeroplane types, in most cases, the fire or explosion was found to be related to design practices, maintenance actions, or improper modification of fuel pumps. Some of the events were apparently caused by lightning strikes. Extensive design reviews were conducted to identify possible ignition sources, and actions were taken that were intended to prevent similar occurrences. However, fuel tank system-related accidents have occurred in spite of these efforts.

On May 11, 1990, the centre wing fuel tank of a Boeing Model 737-300 exploded while the aeroplane was on the ground at Nimoy Aquino International Airport, Manila, Philippines. The aeroplane was less than one year old. In the accident, the fuel-air vapours in the centre wing tank exploded as the aeroplane was being pushed back from a terminal gate prior to flight. The accident resulted in 8 fatalities and injuries to an additional 30 people. Accident investigators considered a plausible scenario in which damaged wiring located outside the fuel tank might have created a short between 115-volt aeroplane system wires and 28 volt wires to a fuel tank level switch. This, in combination with a possible latent defect of the fuel level float switch, was investigated as a possible source of ignition. However, a definitive ignition source was never confirmed during the accident investigation. This unexplained accident occurred on a newer aeroplane, in contrast to the July 17, 1996, accident that occurred on an older Boeing Model 747 aeroplane that was approaching the end of its initial design life.

On July 17, 1996, a Boeing Model 747-100 series aeroplane was involved in an in-flight break-up after takeoff from Kennedy International Airport in New York, resulting in 230 fatalities. The accident investigation indicated that the centre wing fuel tank exploded due to an unknown ignition source.

On March 3, 2001, a Boeing Model 737-400 built in 1991 was parked at gate 62 at the domestic terminal of Bangkok Airport and was being prepared by 5 cabin crew members and 3 ground staff members for a flight to Chiang Mai (Flight TG 114). At 14h48, some 27 minutes before scheduled departure time, an explosion occurred and fire erupted in the cabin, killing a flight attendant and injuring 6 others. The fire was put out in an hour, but by then the aircraft had been gutted by the fire. An explosion of the centre fuel tank caused the accident.

The Boeing Model 747 and 737 accidents indicate that the development of an ignition source inside the fuel tank may be related to both the design and maintenance of the fuel tank systems.

In addition, the FAA and the JAA have reviewed service difficulty reports for the transport aeroplane fleet and evaluated the certification and design practices utilised on these previously certificated aeroplanes. An inspection of fuel tanks on Boeing Model 747 aeroplanes also was initiated. Representatives from the Air Transport Association (ATA), Association of European Airlines (AEA), the Association of Asia Pacific Airlines (AAPA), the Aerospace Industries Association of America, and the European Association of Aerospace Industries initiated a joint effort to inspect and evaluate the condition of the fuel tank system installations on a representative sample of aeroplanes within the transport fleet. The fuel tanks of more than 800 aeroplanes were inspected. Data from inspections conducted as part of this effort and shared with the JAA and FAA have assisted in establishing a basis for developing corrective action for aeroplanes within the transport fleet.

In addition to the results from these inspections, the FAA has received reports of anomalies on in-service aeroplanes that have necessitated actions to preclude development of ignition sources in or adjacent to aeroplane fuel tanks.

The following provides a summary of findings from design evaluations, service difficulty reports, and a review of current aeroplane maintenance practices.

Fuel tank inspections initiated as part of the Boeing Model 747 accident investigation identified ageing of fuel tank system components, contamination, corrosion of components and sulfide deposits on components as possible conditions that could contribute to development of ignition sources within the fuel tanks. Results of detailed inspection of the fuel pump wiring on several Boeing Model 747 aeroplanes showed debris within the fuel tanks consisting of lockwire, rivets, and metal shavings. Debris was also found inside scavenge pumps. Corrosion and damage to insulation on FQIS probe wiring was found on 6 out of 8 probes removed from one in-service aeroplane.

In addition, inspection of aeroplane fuel tank system components from out-of-service (retired) aeroplanes, initiated following the accident, revealed damaged wiring and corrosion build-up of conductive sulfide deposits on the FQIS wiring on some Boeing Model 747 aeroplanes. The conductive deposits or damaged wiring may result in a location where arcing could occur if high power electrical energy was transmitted to the FQIS wiring from adjacent wires that power other aeroplane systems.

While the effects of corrosion on fuel tank system safety have not been fully evaluated, the FAA has initiated a research program to better understand the effects of sulphide deposits and corrosion on the safety of aeroplane fuel tank systems.

Wear or chafing of electrical power wires routed in conduits that are located inside fuel tanks can result in arcing through the conduits. On December 23, 1996, the FAA issued Airworthiness Directive (AD) 96-26-06, applicable to certain Boeing Model 747 aeroplanes, which required inspection of electrical wiring routed within conduits to fuel pumps located in the wing fuel tanks and replacement of any damaged wiring. Inspection reports indicated that many instances of wear had occurred on Teflon sleeves installed over the wiring to protect it from damage and possible arcing to the conduit.

Inspections of wiring to fuel pumps on Boeing Model 737 aeroplanes with over 35,000 flight hours have shown significant wear to the insulation of wires inside conduits that are located in fuel tanks. In nine reported cases, wear resulted in arcing to the fuel pump wire conduit on aeroplanes with greater than 50,000 flight hours. In one case, wear resulted in burnthrough of the conduit into the interior of the 737 main tank fuel cell. On May 14, 1998, the FAA issued a telegraphic AD, T98-11-52, which required inspection of wiring to Boeing Model 737 aeroplane fuel pumps routed within electrical conduits and replacement of any damaged wiring. Results of these inspections showed that wear of the wiring occurred in many instances, particularly on those aeroplanes with high numbers of flight cycles and operating hours.

The JAA also has received reports of corrosion on bonding jumper wires within the fuel tanks on one in-service Airbus Model A300 aeroplane. The manufacturer investigating this event did not have sufficient evidence to determine conclusively the level of damage and corrosion found on the jumper wires. Although the aeroplane was in long-term storage, it does not explain why a high number of damaged/corroded jumper wires were found concentrated in a specific area of the wing tanks. Further inspections of a limited number of other Airbus models did not reveal similar extensive corrosion or damage to bonding jumper wires. However, they did reveal evidence of the accumulation of sulphide deposits around the outer braid of some jumper wires. Tests by the manufacturer have shown that these deposits did not affect the bonding function of the leads. Airbus has developed a one-time-inspection service bulletin for all its aeroplanes to ascertain the extent of the sulphide deposits and to ensure that the level of jumper wire damage found on the one Model A300 aeroplane is not widespread.

On March 30, 1998, the FAA received reports of three recent instances of electrical arcing within fuel pumps installed in fuel tanks on Lockheed Model L-1011 aeroplanes. In one case, the electrical arc had penetrated the pump and housing and entered the fuel tank. Preliminary investigation indicates that features incorporated into the fuel pump design that were intended to preclude overheating and arc-through into the fuel tank may not have functioned as intended due to discrepancies introduced during overhaul of the pumps. Emergency AD 98-08-09 was issued April 3, 1998, to specify a minimum quantity of fuel to be carried in the fuel tanks for the purpose of covering the pumps with liquid fuel and thereby precluding ignition of vapours within the fuel tank until such time as terminating corrective action could be developed.

Other findings have been made on various manufacturers, including Embraer, Bombardier, etc…

4.2 National Transportation Safety Board (NTSB) Recommendations

Since the July 17, 1996, accident, the FAA, NTSB, and aviation industry have been reviewing the design features and service history of the Boeing Model 747 and certain other transport aeroplane models. Based upon its review, the NTSB has issued the following recommendations to the FAA intended to reduce exposure to operation with flammable vapours in fuel tanks and address possible degradation of the original type certificated fuel tank system designs on transport aeroplanes.

The following recommendations relate to “Reduced Flammability Exposure”:

“A-96-174: Require the development of and implementation of design or operational changes that will preclude the operation of transport-category aeroplanes with explosive fuel-air mixtures in the fuel tanks:

LONG TERM DESIGN MODIFICATIONS:

(a) Significant consideration should be given to the development of aeroplane design modification, such as nitrogen-inerting systems and the addition of insulation between heat-generating equipment and fuel tanks. Appropriate modifications should apply to newly certificated aeroplanes and, where feasible, to existing aeroplanes.”

“A-96-175: Require the development of and implementation of design or operational changes that will preclude the operation of transport-category aeroplanes with explosive fuel-air mixtures in the fuel tanks:

NEAR TERM OPERATIONAL

(b) Pending implementation of design modifications, require modifications in operational procedures to reduce the potential for explosive fuel-air mixtures in the fuel tanks of transport-category aircraft. In the B-747, consideration should be given to refuelling the centre wing fuel tank (CWT) before flight whenever possible from cooler ground fuel tanks, proper monitoring and management of the

CWT fuel temperature, and maintaining an appropriate minimum fuel quantity in the CWT."

"A-96-176: Require that the B-747 Flight Handbooks of TWA and other operators of B-747s and other aircraft in which fuel tank temperature cannot be determined by flightcrews be immediately revised to reflect the increases in CWT fuel temperatures found by flight tests, including operational procedures to reduce the potential for exceeding CWT temperature limitations."

"A-96-177: Require modification of the CWT of B-747 aeroplanes and the fuel tanks of other aeroplanes that are located near heat sources to incorporate temperature probes and cockpit fuel tank temperature displays to permit determination of the fuel tank temperatures."

The following recommendations relate to "Ignition Source Reduction":

"A-98-36: Conduct a survey of fuel quantity indication system probes and wires in Boeing Model 747's equipped with systems other than Honeywell Series 1-3 probes and compensators and in other model aeroplanes that are used in Title 14 Code of Federal Regulations Part 121 service to determine whether potential fuel tank ignition sources exist that are similar to those found in the Boeing Model 747. The survey should include removing wires from fuel probes and examining the wires for damage. Repair or replacement procedures for any damaged wires that are found should be developed."

"A-98-38: Require in Boeing Model 747 aeroplanes, and in other aeroplanes with fuel quantity indication system (FQIS) wire installations that are co-routed with wires that may be powered, the physical separation and electrical shielding of FQIS wires to the maximum extent possible."

"A-98-39: Require, in all applicable transport aeroplane fuel tanks, surge protection systems to prevent electrical power surges from entering fuel tanks through fuel quantity indication system wires."

4.3 Unforeseen Fuel Tank System Failures

After an extensive review of the Boeing Model 747 design following the July 17, 1996, accident, the FAA determined that during original certification of the fuel tank system, the degree of tank contamination and the significance of certain failure modes of fuel tank system components had not been considered to the extent that more recent service experience indicates is needed. For example, in the absence of contamination, the FQIS had been shown to preclude creating an arc if FQIS wiring were to come in contact with the highest level of electrical voltage on the aeroplane. This was shown by demonstrating that the voltage needed to cause an arc in the fuel probes due to an electrical short condition was well above any voltage level available in the aeroplane systems.

However, recent testing has shown that if contamination, such as conductive debris (lock wire, nuts, bolts, steel wool, corrosion, sulphide deposits, metal filings, etc.) is placed within gaps in the fuel probe, the voltage needed to cause an arc is within values that may occur due to a subsequent electrical short or induced current on the FQIS probe wiring from electromagnetic interference caused by adjacent wiring. These anomalies, by themselves, could not lead to an electrical arc within the fuel tanks without the presence of an additional failure. If any of these anomalies were combined with a subsequent failure within the electrical system that creates an electrical short, or if high-intensity radiated fields (HIRF) or electrical current flow in adjacent wiring induces EMI voltage in the FQIS wiring, sufficient energy could enter the fuel tank and cause an ignition source within the tank.

On November 26, 1997, in Docket No. 97-NM-272-AD, the FAA proposed a requirement for operators of Boeing Model 747-100, -200, and -300 series aeroplanes to install components for the suppression of electrical transients and/or the installation of shielding and separation of fuel quantity indicating system wiring from other aeroplane system wiring. After reviewing the comments received on the proposed requirements, the FAA issued AD 98-20-40 on September 23, 1998, that requires the installation of shielding and separation of the electrical wiring of the fuel quantity indication system. On April 14, 1998, the FAA proposed a similar requirement for Boeing Model 737-100, -200, -300, -400, and -500 series aeroplanes in Docket No. 98-NM-50-AD, which led to the FAA issuing AD 99-03-04 on January 26, 1999. The action required by those two airworthiness directives is intended to preclude high levels of electrical energy from entering the aeroplane fuel tank wiring due to electromagnetic interference or electrical shorts. Several manufacturers have been granted approval for the use of alternative methods of compliance (AMOC) with these AD's that permit installation of transient suppressing devices in the FQIS wiring that prevent unwanted electrical power from entering the fuel tank. All later model Boeing Model 747 and 737 FQIS's have wire separation and fault isolation features that may meet the intent of these AD actions. This rulemaking will require evaluation of these later designs and the designs of other transport aeroplanes.

Other examples of unanticipated failure conditions include incidents of parts from fuel pump assemblies impacting or contacting the rotating fuel pump impeller. The first design anomaly was identified when two incidents of damage to fuel pumps were reported on Boeing Model 767 aeroplanes. In both cases objects from a fuel pump inlet diffuser assembly were ingested into the fuel pump, causing damage to the pump impeller and pump housing. The damage could have caused sparks or hot debris from the pump to enter the fuel tank. To address this unsafe condition, the FAA issued AD 97-19-15. This AD requires revision of the aeroplane flight manual to include procedures to switch off the fuel pumps when the centre tank approaches empty. The intent of this interim action is to maintain liquid fuel over the pump inlet so that any debris generated by a failed fuel pump will not come in contact with fuel vapours and cause a fuel tank explosion.

The second design anomaly was reported on Boeing Model 747-400 series aeroplanes. The reports indicated that inlet adapters of the override/jettison pumps of the centre wing fuel tank were worn. Two of the inlet adapters had worn down enough to cause damage to the rotating blades of the inducer. The inlet check valves also had significant damage. An operator reported damage to the inlet adapter so severe that contact had occurred between the steel disk of the inlet check valve and the steel screw that holds the inducer in place. Wear to the inlet adapters has been attributed to contact between the inlet check valve and the adapter. Such excessive wear of the inlet adapter can lead to contact between the inlet check valve and inducer, which could result in pieces of the check valve being ingested into the inducer and damaging the inducer and impellers. Contact between the steel disk of the inlet check valve and the steel rotating inducer screw can cause sparks. To address this unsafe condition, the FAA issued an immediately adopted rule, AD 98-16-19, on July 30, 1998.

Another design anomaly was reported in 1989 when a fuel tank ignition event occurred during refuelling of a Beech Model 400 aeroplane. The auxiliary fuel tank had been installed under an STC. Polyurethane foam had been installed in portions of the tank to minimise the potential of a fuel tank explosion if uncontained engine debris penetrated those portions of the tank. The accident investigation indicated that electrostatic charging of the foam during refuelling resulted in ignition of fuel-air vapours in portions of the adjacent fuel tank system that did not contain the foam. The fuel vapour explosion caused distortion of the tank and fuel leakage from a failed fuel line. Modifications to the design, including use of more conductive polyurethane foam and installation of a standpipe in the refuelling system, were incorporated to prevent reoccurrence of electrostatic charging and a resultant fuel tank ignition source.

4.4 Listing of Deficiencies

The list provided below summarises fuel tank system design deficiencies, malfunctions, failures, and maintenance-related actions that have been determined through service experience to result in a degradation of the safety features of aeroplane fuel tank systems. This list was developed from service difficulty reports and incident and accident reports. These anomalies occurred on in-service transport category aeroplanes despite regulations and policies in place to preclude the development of ignition sources within aeroplane fuel tank systems.

1. Pumps:
   - Ingestion of the pump inducer into the pump impeller and generation of debris into the fuel tank.
   - Pump inlet case degradation, allowing the pump inlet check valve to contact the impeller.
   - Stator winding failures during operation of the fuel pump. Subsequent failure of a second phase of the pump resulting in arcing through the fuel pump housing.
   - Deactivation of thermal protective features incorporated into the windings of pumps due to inappropriate wrapping of the windings.
   - Omission of cooling port tubes between the pump assembly and the pump motor assembly during fuel pump overhaul.
   - Extended dry running of fuel pumps in empty fuel tanks, which was contrary to the manufacturer’s recommended procedures.
   - Use of steel impellers that may produce sparks if debris enters the pump.
   - Debris lodged inside pumps.
   - Arcing due to the exposure of electrical connections within the pump housing that have been designed with inadequate clearance to the pump cover.
   - Thermal switches resetting over time to a higher trip temperature.
   - Flame arrestors falling out of their respective mounting.
   - Internal wires coming in contact with the pump rotating group, energising the rotor and arcing at the impeller/adapter interface.
   - Poor bonding across component interfaces.
   - Insufficient ground fault current protection capability.
   - Poor bonding of components to structure.

2. Wiring to pumps in conduits located inside fuel tanks:
   - Wear of Teflon sleeving and wiring insulation allowing arcing from wire through metallic conduits into fuel tanks.

3. Fuel pump connectors:
   - Electrical arcing at connections within electrical connectors due to bent pins or corrosion.
   - Fuel leakage and subsequent fuel fire outside of the fuel tank caused by corrosion of electrical connectors inside the pump motor which lead to electrical arcing through the connector housing (connector was located outside the fuel tank).
   - Selection of improper materials in connector design.

4. FQIS wiring:
   - Degradation of wire insulation (cracking), corrosion and sulfide deposits at electrical connectors
   - Unshielded FQIS wires routed in wire bundles with high voltage wires.

5. FQIS probes:
   - Corrosion and sulfide deposits causing reduced breakdown voltage in FQIS wiring.
   - Terminal block wiring clamp (strain relief) features at electrical connections on fuel probes causing damage to wiring insulation.
   - Contamination in the fuel tanks causing a reduced arc path between FQIS probe walls (steel wool, lock wire, nuts, rivets, bolts; or mechanical impact damage to probes).

6. Bonding straps:
   - Corrosion to bonding straps.
   - Loose or improperly grounded attachment points.
   - Static bonds on fuel tank system plumbing connections inside the fuel tank worn due to mechanical wear of the plumbing from wing movement and corrosion.

7. Electrostatic charge:
   - Use of non-conductive reticulated polyurethane foam that holds electrostatic charge buildup.
   - Spraying of fuel into fuel tanks through inappropriately designed refuelling nozzles or pump cooling flow return methods.

4.5 Fuel Tank Flammability

The traditional certification approach for fuel tank certification is the elimination of ignition sources from the fuel system; fuel tank safety is currently achieved primarily by eliminating ignition sources from the fuel system. However, some large transport aircraft designs have shown undesirable features, allowing otherwise avoidable heat transfer into the fuel tank, that may result in a significant increase in the risk of an explosion. Although the fuel 'flash-point' can be reached, usually in normal (hot ambient) operating conditions, a relatively high ignition source energy is needed to cause tank ignition. Tanks heated additionally from external system sources, will have a greater probability of ignition from low energy ignition sources. Typical examples of such are ECS packs located nearby fuel tanks, without any insulation or mitigation device to protect the tanks. Simple, practical design precautions could have been introduced into those aircraft that could have prevented the heat transfer (for the example given above, other aircraft have thermal insulation and/or cooling fan).

It therefore appears appropriate to require an assessment of the heat transfer into the fuel system, with the intention of identifying whether the tanks are being needlessly heated. However, JAA have considered that assessing flammability exposure using sophisticated or complex models is not necessary and a qualitative assessment should be generally sufficient.

The in-service data (ref. FTHWG final report, dated July 1998) shows that the general in-service experience is satisfactory for wing tanks and unheated centre tanks. Inerting systems, including ground-based systems, have not been shown yet to be technically mature for commercial aviation use and it could be expected that a cost/benefit analysis would not show an overall benefit.

FAA has introduced in Amendment 102 a requirement to assess the flammability exposure of fuel tanks. JAA is sharing the same concern, however, the FAA proposal is relying on Advisory Material still under development. As a consequence, JAA is proposing a simpler requirement, backed by a very short ACJ.

5. Discussion of the final rule

The review of the service history, design features, and maintenance instructions of the transport aeroplane fleet indicates that ageing of fuel tank system components and unforeseen fuel tank system failures and malfunctions have become a safety issue for the fleet of turbine-powered transport category aeroplanes. It is proposed to amend the current JAR-25 regulations in 2 areas : ignition sources and flammability.

The first area of concern encompasses the need to require the design of future transport category aeroplanes to more completely address potential failures in the fuel tank system that could result in an ignition source in the fuel tank system.

Secondly, certain aeroplane types are designed with heat sources adjacent to the fuel tank, which results in heating of the fuel and a significant increase in the formation of flammable vapours in the tank. It is considered that fuel tank safety can be enhanced by reducing the time during which fuel tanks operate with flammable vapours in the tank.   The JAA is therefore adopting a new requirement to provide design precautions to minimise the formation of flammable vapours in fuel tanks, or to provide means to prevent catastrophic damage if ignition does occur.

Currently, JAR 25.981 (identical to FAR §25.981 pre Amendment 102) defines limits on surface temperatures within transport aeroplane fuel tank systems. In order to address future aeroplane designs, JAR 25.981 is revised to address both prevention of ignition sources in fuel tanks, and reduction in the time fuel tanks contain flammable vapours. The first part explicitly includes a requirement for effectively precluding ignition sources within the fuel tank systems of transport category aeroplanes. The second part requires minimising the formation of flammable vapours in the fuel tanks.

As a general rule, the proposed JAR-25 changes are using the structure of the FAR § 25.981 as changed by Amendment 102. However, considering JAA comments, some requirements adopted by FAR 25 have not been adopted. The changes related to the elimination of ignition sources from the fuel system are identical to JAA INT/POL/25/12, published at issue 1 on 1st of October 2000.

5.1 Fuel Tank Ignition Source - JAR 25.981

The title of JAR 25.981 is changed from “Fuel tank temperature” to “Fuel tank ignition prevention.” The substance of existing paragraph (a), which requires the applicant to determine the highest temperature that allows a safe margin below the lowest expected auto ignition temperature of the fuel, is retained. Likewise, the substance of existing paragraph (b), which requires precluding the temperature in the fuel tank from exceeding the temperature determined under paragraph (a), is also retained. These requirements are redesignated as (a)(1) and (2) respectively.

Compliance with these paragraphs requires the determination of the fuel flammability characteristics of the fuels approved for use. Fuels approved for use on transport category aeroplanes have differing flammability characteristics. The fuel with the lowest autoignition temperature is JET A (kerosene), which has an autoignition temperature of approximately 232°C at sea level. The autoignition temperature of JP-4 is approximately 243°C at sea level. Under the same atmospheric conditions, the autoignition temperature of gasoline is approximately 426°C. The autoignition temperature of these fuels increases at increasing altitudes (lower pressures). For the purposes of this rule, the lowest temperature at which autoignition can occur for the most critical fuel approved for use should be determined. A temperature providing a safe margin is at least 10°C below the lowest expected autoignition temperature of the fuel throughout the altitude and temperature envelopes approved for the aeroplane type for which approval is requested.
This rulemaking also adds a new paragraph (a)(3) to require that a safety analysis be performed to demonstrate the presence of an ignition source in the fuel tank. Contrary to FAR-25 proposal, which is requiring that an ignition source could not result from any single failure in combination with any latent failure condition not shown to be extremely remote, the proposed JAR 25.981(a)(3) is referring directly to JAR 25.1309. The JAA do consider that the latent failure consideration proposed in FAR 25.981(a)(3) is not consistent with the assessments performed for the other systems, and in some areas of the fuel system, be inappropriate. Direct reference to 1309 will ensure enforcement of consistent, well-accepted criteria.

JAA is not proposing yet a similar requirement to FAR 25.981(b). The purpose of FAR 25.981(b), to require that critical design configuration control limitations, inspections, or other procedures be established as necessary to prevent development of ignition sources within the fuel tank system, and that they be included in the Airworthiness Limitations section of the ICA required by § 25.1529, is far exceeding the scope of this NPA. It is therefore considered that any change to JAR-25 in that respect should be undertaken by the relevant Steering Group, to address the issue at the aeroplane level, and not only at the fuel system level.

5.2 Flammability Requirements

The ARAC Fuel Tank Harmonization Working Group (FTHWG) has submitted a recommendation to the FAA that the FAA continue to evaluate means for minimising the development of flammable vapours within the fuel tanks. Development of a definitive standard to address this recommendation will require additional effort that will likely take some time to complete. In the meantime, however, the FAA is aware that historically certain design methods have been found acceptable that, when compared to readily available alternative methods, increase the likelihood that flammable vapours will develop in the fuel tanks. For example, in some designs, including the Boeing Model 747, air conditioning packs have been located immediately below a fuel tank without provisions to reduce transfer of heat from the packs to the tank.

Therefore, in order to preclude the future use of such design practices, FAR § 25.981 is revised to add a requirement that fuel tank installations be designed to minimise the development of flammable vapours in the fuel tanks. Alternatively, if an applicant concludes that such minimisation is not advantageous, it may propose means to mitigate the effects of an ignition of fuel vapours in the fuel tanks. For example, such means might include installation of fire suppressing polyurethane foam.

This FAR rule is not intended to fully prevent the development of flammable vapours in fuel tanks because total prevention has currently not been found to be feasible. Rather, it is intended as an interim measure to preclude, in new designs, the use of design methods that result in a relatively high likelihood that flammable vapours will develop in fuel tanks when other practicable design methods are available that can reduce the likelihood of such development. For example, the rule does not prohibit installation of fuel tanks in the cargo compartment, placing heat exchangers in fuel tanks, or locating a fuel tank in the centre wing. It does, however, require that practical means, such as transferring heat from the fuel tank (e.g., use of ventilation or cooling air), be incorporated into the aeroplane design if heat sources were placed in or near the fuel tanks that significantly increased the formation of flammable fuel vapours in the tank, or if the tank is located in an area of the aeroplane where little or no cooling occurs. The intent of the rule is to require that fuel tanks are not heated, and cool at a rate equivalent to that of a wing tank in the transport aeroplane being evaluated. This may require incorporating design features to reduce flammability, for example cooling and ventilation means or inerting for fuel tanks located in the centre wing box, horizontal stabiliser, or auxiliary fuel tanks located in the cargo compartment.

The JAA, considering that the restriction of flammable vapours may create confusion, especially regarding the natural development of those vapours, has opted for a simpler text.

5.3 FAA Advisory Material

In addition to the amendments presented in this rulemaking, the FAA has issued AC 25.981-1B, “Fuel Tank Ignition Source Prevention Guidelines” (a revision to AC 25.981-1A), and a new AC 25.981-2, “Fuel Tank Flammability Minimization.”

AC 25.981-1B includes consideration of failure conditions that could result in sources of ignition of vapours within fuel tanks, and provides guidance on how to substantiate that ignition sources will not be present in aeroplane fuel tank systems following failures or malfunctions of aeroplane components or systems. This AC also includes guidance for developing any limitations for the ICA that may be generated by the fuel tank system safety review.

AC 25.981-2 provides information and guidance concerning compliance with the new flammability requirements. This AC contains information pertaining to minimizing the formation or mitigation of hazards from flammable fuel air mixtures within fuel tanks.

5.4 JAA Advisory Material

Regarding ignition prevention, JAA has issued Advisory Material, already implemented as a complement to INT/POL/25/12 on some certification or validation projects by Certification Review Items (CRI's), and attached to the JAA letter recommending to NAA that a fuel tank safety design review should be conducted (JAA letter ref. 04/00/02/07/01-L296 dated 4 March 4, 2002). It is proposed as an ACJ in appendix 1.

For Flammability reduction, the JAA propose a simple ACJ, which identifies the considerations, to be assessed, when compliance with JAR 25.981(c) is being reviewed.

II-D. JAA NPA 25E-342 COMMENT-RESPONSE DOCUMENT

1. <u>CAA-UK comments</u>

1.1 Editorial comments
All editorial comments provided by CAA have been introduced into the proposed text.

1.2 Bonding scheme
CAA is proposing a revised text, to address the need for redundant bonding schemes (ACJ 25.981(a), §5.2c, page 14).
This proposal appears to reflect the intent of the proposed text, and has therefore been adopted.

1.3 Energy level
This comment addresses §3.1 of the proposed ACJ 25.981(a), dealing with the maximum energy allowable into the tank.
As agreed by the commenter, the 200 µJ is universally accepted, especially for lightning / HIRF /EMI certification. As indicated in the proposed ACJ, it may be desirable to have additional margin for the fuel system equipment under normal conditions. However, at this stage, JAA is not in a position to define any firm value for this additional margin. FAA, in the draft AC 25.981-1C, apparently decided for an order a magnitude and proposed a value of 20 µJ. JAA is not supporting this move, considering that (1) there is no data (in-service experience, laboratory testing, etc…) supporting a 20 µJ limit, and (2) this will prevent certification of a large portion of the gauging systems currently flying, which may be unjustified, and also, considering this practical implications, may be qualified of being typical “rulemaking by AC”.
It is therefore proposed to leave the proposed ACJ unchanged. It may be revised in the future is there is a consensus about the adequate margin.

2. <u>Cessna comment</u>

This comment is focussing on the applicability criteria of the proposed requirement, and implies there should be a restriction to the applicability of the safety assessment to aeroplanes carrying more than 30 passengers or 3 400 kg of payload. In the commenter view, this will harmonize the JAA proposal with FAA SFAR 88.
This comment is rejected, as JAA intention is that the new policy will be applicable to all products, similarly to FAA FAR 25 Amendment 102. The restriction of the applicability is only relevant of the in-service product review (not the subject of this NPA), and is harmonised between FAA and JAA.

3. <u>Other comments</u>

Other comments submitted on NPA 25E-342 were concurring with the proposal.

4. <u>FAA comments</u>

Due to a transmission problem, the FAA comments were submitted after the comment period. However, they have been considered :-

4.1 Proposed JAR 25.981(a)(3) requires a JAR 25.1309 type analysis to demonstrate that an ignition source does not result from each single failure and from all combination of failures not shown to be Extremely Improbable per JAR 25.1309. This approach does not

yield the same results as what is required from FAR 25.981(a)(3) which is a more rigorous requirement which is based on traditional powerplant certification requirements (FAR 25.901) and established policy for powerplant systems, which include fuel tank systems.
<u>*Response*</u> : this is a major difference, well identified, and unlikely to be resolved. JAA considers that the fuel system is not well suited to the proposed latent fault policy as proposed by FAA. The technical solutions involved, such as barrier devices (TSU/TSD) are not justified, from a cost / benefit point of view.

4.2 The proposed requirements of FAR 25.981(b) is not included in the proposed JAR 25.981. In the "Discussion of the Final Rule" section it is stated that the development of airworthiness limitations (ALI's) far exceeds the scope of the NPA. And it is further stated that any change to JAR-25 in this respect should be undertaken by the relevant Steering Group to address the issue at the airplane level, not only the fuel system level. Later in ACJ 25.981(a) [Appendix 1 of this NPA], Section 6, it is stated that the analysis conducted to show compliance with JAR 25.981(a) may result in the need to define certain required inspection or maintenance items. This is the intent of FAR 25.981(b).
<u>*Response*</u> : difference of opinion noted.

4.3 The proposed JAR 25.981(c) is also not as rigorous a requirement as FAR 25.981(c) which is based on the recommendation of a new rule in the final report of the 1998 Aviation Rulemaking Advisory Committee's Fuel Tank Harmonization Working Group. The FAA believes FAR 25.981(c) [amendment 25-102] provides a level of safety that is achievable and practical, especially considering the recent development of a practical fuel tank inerting system.
<u>*Response*</u> : it is proposed to proceed with the publication of the proposed JAR 25.981(c) by NPA 25 E-342, which is addressing the main concern – large heat input into the fuel system – with some basic requirements and guidance material. The rule may be revised in the short to medium term, to consider the likely development in the short to medium term, of an harmonised criteria allowing the identification – and the ‘treatment’- of high flammability tanks.