AMC 20-2A
Certification of Essential APU Equipped with Electronic Controls

1. GENERAL

The existing regulations for APU and aircraft certification may require special interpretation for essential APU equipped with electronic control systems. Because of the nature of this technology it has been found necessary to prepare acceptable means of compliance specifically addressing the certification of these control systems.

Like any acceptable means of compliance, the content of this document is not mandatory. It is issued for guidance purposes, and to outline a method of compliance with the airworthiness code. In lieu of following this method, an alternative method may be followed, provided that this is agreed by the Agency as an acceptable method of compliance with the airworthiness code.

This document discusses the compliance tasks relating to both the APU and the aircraft certification.

2 REFERENCE SPECIFICATIONS

2.1 *APU Certification*

CS-APU

Book 1, paragraph 2(c)

Book 1, Section A, paragraphs 10(b), 20, 80, 90, 210, 220, 280 and 530

Book 2, Section A, AMC CS-APU 20

2.2 *Aircraft Certification*

Aeroplane: CS-25

Paragraphs 581, 899, 1301, 1307(c), 1309, 1351(b)(d), 1353(a)(b), 1355(c), 1357, 1431, 1461, 1524, 1527

A9011, A903, A939, A1141, A1181, A1183, A1189, A1305, A1337, A1521, A1527, B903, B1163

3 SCOPE

This acceptable means of compliance provides guidance for electronic (analogue and digital) essential APU control systems, on the interpretation and means of compliance with the relevant APU and aircraft certification requirements.

It gives guidance on the precautions to be taken for the use of electronic technology for APU control, protection and monitoring and, where applicable, for integration of functions specific to the aircraft.

Precautions have to be adapted to the criticality of the functions. These precautions may be affected by -

Degree of authority of the system,

Phase of flight,

Availability of back-up system.

This document also discusses the division of compliance tasks between the APU and aircraft certification.

4 PRECAUTIONS

4.1 *General*

The introduction of electronic technology can entail the following:

(a) A greater dependence of the APU on the aircraft owing to the use of electrical power and/or data supplied from the aircraft,

(b) Risk of significant failures which might, for example, occur as a result of -

(i) Insufficient protection from electromagnetic disturbance (lightning, internal or external radiation effects),

(ii) Insufficient integrity of the aircraft electrical power supply,

(iii) Insufficient integrity of data supplied from the aircraft,

(iv) Hidden design faults or discrepancies contained within the design of the APU control software, or

(v) Omissions or errors in the system specification.

Special design and integration precautions must therefore be taken to minimise these risks.

4.2 *Objective*

The introduction of electronic control systems should provide for the aircraft at least the equivalent safety, and the related reliability level, as achieved by essential APU equipped with hydro-mechanical control and protection systems.

This objective, when defined during the aircraft/APU certification for a specific application, will be agreed with the Agency.

4.3 *Precautions relating to APU control, protection and monitoring*

The software associated with APU control, protection and monitoring functions must have a software level and architecture appropriate to their criticality (see paragraph 4.2).

For digital systems, any residual errors not activated during the software development and certification process could cause an unacceptable failure. The latest edition of AMC 20-115 constitutes an acceptable means of compliance for software development, verification and software aspects of certification. The APU software should be at least level B according to the industry documents referred in the latest edition of AMC 20-115. In some specific cases, level A may be more appropriate.

It should be noted the software disciplines described in the latest edition of AMC 20-115 may not, in themselves, be sufficient to ensure that the overall system safety and reliability targets have been achieved. This is particularly true for certain critical systems, such as fully authority digital control systems. In such cases it is accepted that other measures, usually within the system, in addition to a high level of software discipline may be necessary to achieve these safety objectives and demonstrate that they have been met.

It is outside the scope of the latest edition of AMC 20-115 to suggest or specify these measures, but in accepting that they may be necessary, it is also the intention to encourage the development of software techniques which could support meeting the overall system safety objectives.

4.4 *Precautions relating to APU independence from the aircraft*

4.4.1 *Precautions relating to electrical power supply and data from the aircraft*

When considering the objectives of paragraph 4.2, due consideration must be given to the reliability of electrical power and data supplied to the electronic controls and peripheral components. Therefore the potential adverse effects on APU operation of any loss of electrical power supply from the aircraft or failure of data coming from the aircraft must be assessed during the APU certification.

(a) Electrical power

The use of either the aircraft electrical power network or electrical power sources specific to the APU, or the combination of both, may meet the objectives.

If the aircraft electrical system supplies power to the APU control system at any time, the power supply quality, including transients or failures, must not lead to a situation identified during the APU certification which is considered during the aircraft certification to be a hazard to the aircraft.

(b) Data

The following cases should be considered:

(i) Erroneous data received from the aircraft by the APU control system, and

(ii) Control system operating faults propagating via data links.

In certain cases, defects of aircraft input data may be overcome by other data references specific to the APU in order to meet the objectives.

4.4.2 *Local Events*

(a) In designing an electronic control system to meet the objectives of paragraph 4.2, special consideration needs to be given to local events.

Examples of local events include fluid leaks, mechanical disruptions, electrical problems, fires or overheat conditions. An overheat condition results when the temperature of the electronic control unit is greater than the maximum safe design operating temperature declared during the APU certification. This situation can increase the failure rate of the electronic control system.

(b) Whatever the local event, the behaviour of the electronic control system must not cause a hazard to the aircraft. This will require consideration of effects such as the overspeed of the APU.

When the demonstration that there is no hazard to the aircraft is based on the assumption that there exists another function to afford the necessary protection, it must be shown that this function is not rendered inoperative by the same local event (including destruction of wires, ducts, power supplies).

(c) Specific design features or analysis methods may be used to show compliance with respect to hazardous effects. Where this is not possible, for example due to the variability or the complexity of the failure sequence, then testing may be required. These tests must be agreed with the Agency.

4.4.3 *Lightning and other electromagnetic effects*

Electronic control systems are sensitive to lightning and other electromagnetic interference. The system design must incorporate sufficient protection in order to ensure the functional integrity of the control system when subjected to designated levels of electric or electromagnetic inductions, including external radiation effects.

The validated protection levels for the APU electronic control system must be detailed during the APU certification in an approved document. For aircraft certification, it must be substantiated that these levels are adequate.

4.5 *Other functions integrated into the electronic control system*

If functions other than those directly associated with the control of the APU are integrated into the electronic control system, the APU certification should take into account the applicable aircraft requirements.

5 INTER-RELATION BETWEEN APU AND AIRCRAFT CERTIFICATION

5.1 *Objective*

To satisfy the CS aircraft requirements, such as CS 25A901, CS 25A903 and CS 25.1309, an analysis of the consequences of failures of the system on the aircraft has to be made. It should be ensured that the software levels and safety and reliability objectives for the electronic control system are consistent with these requirements.

5.2 *Interface definition*

The interface has to be identified for the hardware and software aspects between the APU and aircraft systems in the appropriate documents.

The APU documents should cover in particular -

(a) The software quality level (per function if necessary),

(b) The reliability objectives for -

APU shut-down in flight,

Loss of APU control or significant change in performance,

Transmission of faulty parameters,

(c) The degree of protection against lightning or other electromagnetic effects (e.g. level of induced voltages that can be supported at the interfaces),

(d) APU and aircraft interface data and characteristics, and

(e) Aircraft power supply and characteristics (if relevant).

5.3 *Distribution of compliance demonstrations*

The certification of the APU equipped with electronic controls and of the aircraft may be shared between the APU certification and aircraft certification. The distribution between the APU certification and the aircraft certification must be identified and agreed with the Agency and/or the appropriate APU and aircraft Authorities (an example is given in appendix).

Appropriate evidence provided for APU certification should be used for aircraft certification. For example, the quality of any aircraft function software and aircraft/APU interface logic already demonstrated for APU certification should need no additional substantiation for aircraft certification.

Aircraft certification must deal with the specific precautions taken in respect of the physical and functional interfaces with the APU.

APPENDIX

An example of tasks distribution between APU and aircraft certification

FUNCTIONS OR INSTALLATION CONDITIONS	SUBSTANTIATION UNDER CS-APU	SUBSTANTIATION UNDER CS-25	
APU CONTROL AND PROTECTION	- Safety objective - Software level	- Reliability - Software level	
MONITORING	- Independence of control and monitoring parameters	- Monitoring parameter reliability	- Indication system reliability
AIRCRAFT DATA	- Protection of APU from aircraft data failures - Software level		- Aircraft data reliability
CONTROL SYSTEM ELECTRICAL SUPPLY			- Reliability and quality of aircraft supply if used