

AMC 20-1 Effective: 26/12/2007

Annex II to ED Decision 2007/019/R of 19/12/2007

AMC 20-1

Certification of Aircraft Propulsion Systems Equipped with Electronic Control Systems

TABLE OF CONTENTS

1	GENERAL.....	1
2	RELEVANT SPECIFICATIONS	1
3	SCOPE.....	1
4	PRECAUTIONS	2
	a) General.....	2
	b) Objective.....	2
	c) Precautions relating to electrical power supply and data from the Aircraft.....	2
	d) Local events	3
	e) Software and Programmable Logic Devices	3
	f) Environmental effects.....	3
5	INTER-RELATION BETWEEN ENGINE, PROPELLER AND AIRCRAFT CERTIFICATION.....	3
	a) Objective.....	3
	b) Interface Definition.....	3
	c) Distribution of Compliance Demonstration	3
6	TABLE.....	5

1 GENERAL

The existing specifications for Engine, Propeller and Aircraft certification may require special interpretation for Engines and Propellers equipped with electronic control systems. Because of the nature of this technology and because of the greater interdependence of Engine, Propeller and Aircraft systems, it has been found necessary to prepare acceptable means of compliance specifically addressing the certification of these control systems.

This AMC 20-1 addresses the compliance tasks relating to certification of the installation of propulsion systems equipped with electronic control systems. AMC 20-3 is dedicated to certification of Engine Control Systems but identifies some Engine installation related issues that should be read in conjunction with this AMC 20-1. Like any acceptable means of compliance, it is issued to outline issues to be considered during demonstration of compliance with the certification specifications.

2 RELEVANT SPECIFICATIONS

For Aircraft certification, the main related certification specifications are:

- For Aeroplanes: CS-25 (and, where applicable, CS-23)
Paragraphs: 33, 581, 631, 899, 901, 903, 905, 933, 937, 939, 961, 994, 995, 1103(d), 1143 (except (d)), 1149, 1153, 1155, 1163, 1181, 1183, 1189, 1301, 1305, 1307(c), 1309, 1337, 1351(b)(d), 1353(a)(b), 1355(c), 1357, 1431, 1461, 1521(a), 1527.
- For Rotorcraft: equivalent specifications in CS-27 and CS-29.

3 SCOPE

This acceptable means of compliance is relevant to certification specifications for Aircraft installation of Engines or Propellers with electronic control systems, whether using electrical or electronic (analogue or digital) technology.

It gives guidance on the precautions to be taken for the use of electrical and electronic technology for Engine and Propeller 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: the degree of authority of the system; the phase of flight; and the availability of a Back-up System.

AMC 20-1 Effective: 26/12/2007

Annex II to ED Decision 2007/019/R of 19/12/2007

This document also discusses the division of compliance tasks between the applicants for Engine, Propeller (when applicable) and Aircraft certifications. This guidance relates to issues to be considered during Aircraft certification.

It does not cover APU control systems. APUs which are not used as “propulsion systems”, are addressed in the dedicated AMC 20-2.

4 PRECAUTIONS

a) General

The introduction of electrical and electronic technology can entail the following:

- a greater dependence of the Engine or Propeller on the Aircraft owing to the use of electrical power and or data supplied from the Aircraft.
- an increased integration of control and related indication functions,
- an increased risk of significant Failures common to more than one Engine or Propeller of the Aircraft which might, for example, occur as a result of:
 - Insufficient protection from electromagnetic disturbance (lightning, internal or external radiation effects),
 - Insufficient integrity of the Aircraft electrical power supply,
 - Insufficient integrity of data supplied from the Aircraft,
 - Hidden design Faults or discrepancies contained within the design of the propulsion system control software or complex electronic hardware, or
 - Omissions or errors in the system/software specification.

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

b) Objective

The introduction of electronic control systems should provide for the Aircraft at least the equivalent safety, and the related reliability level, as achieved in Aircraft equipped with Engine and Propellers using hydromechanical control and protection systems.

When possible, early co-ordination between the Engine, Propeller and Aircraft applicants is recommended in association with the Agency, as discussed under paragraph (5) of this AMC.

c) Precautions relating to electrical power supply and data from the Aircraft

When considering the objectives of paragraph 4 (a) or (b), due consideration should be given to the reliability of electrical power and data supplied to the electronic control systems and peripheral components. The potential adverse effects on Engine and Propeller operation of any loss of electrical power supply from the Aircraft or failure of data coming from the Aircraft are assessed during the Engine and Propeller certification.

During Aircraft certification, the assumptions made as part of the Engine and Propeller certification on reliability of Aircraft power and data should be checked for consistency with the actual Aircraft design.

Aircraft should be protected from unacceptable effects of Faults due to a single cause, simultaneously affecting more than one Engine or Propeller. In particular, the following cases should be considered:

- Erroneous data received from the Aircraft by the Engine/Propeller control system if the data source is common to more than one Engine/Propeller (e.g. air data sources, autothrottle synchronising), and
- Control system operating Faults propagating via data links between Engine/Propellers (e.g. maintenance recording, common bus, cross-talk, autofeathering, automatic reserve power system).

AMC 20-1 Effective: 26/12/2007

Annex II to ED Decision 2007/019/R of 19/12/2007

Any precautions needed may be taken either through the Aircraft system architecture or by logic internal to the electronic control system.

d) Local events

For Engine and Propeller certification, effects of local events should be assessed.

Whatever the local event, the behaviour of the electronic control system should not cause a hazard to the Aircraft. This will require consideration of effects such as the control of the thrust reverser deployment, the overspeed of the Engine, transient effects or inadvertent Propeller pitch change under any flight condition.

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 should be shown that this function is not rendered inoperative by the same local event (including destruction of wires, ducts, power supplies).

Such assessment should be reviewed during Aircraft certification.

e) Software and Programmable Logic Devices

The acceptability of levels and methods used for development and verification of software and Programmable Logic Devices which are part of the Engine and Propeller type designs should have been agreed between the Aircraft, Engine and Propeller designers prior to certification activity.

f) Environmental effects

The validated protection levels for the Engine and Propeller electronic control systems as well as their emissions of radio frequency energy are established during the Engine and Propeller certification and are contained in the instructions for installation. For the Aircraft certification, it should be substantiated that these levels are adequate.

5 INTER-RELATION BETWEEN ENGINE, PROPELLER AND AIRCRAFT CERTIFICATION

a) Objective

To satisfy the Aircraft certification specifications, such as CS 25.901, CS 25.903 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.

b) Interface Definition

The interface has to be identified for the hardware and software aspects between the Engine, Propeller and the Aircraft systems in the appropriate documents.

The Engine/Propeller/Aircraft documents should cover in particular:

- The software quality level (per function if necessary),
- The reliability objectives for loss of Engine/Propeller control or significant change in thrust, (including IFSD due to control system malfunction), transmission of faulty parameters,
- The degree of protection against lightning or other electromagnetic effects (e.g. level of induced voltages that can be supported at the interfaces),
- Engine, Propeller and Aircraft interface data and characteristics, and
- Aircraft power supply and characteristics (if relevant).

c) Distribution of Compliance Demonstration

The certification tasks of the Aircraft propulsion system equipped with electronic control systems may be shared between the Engine, Propeller and Aircraft certification. The

AMC 20-1 Effective: 26/12/2007

Annex II to ED Decision 2007/019/R of 19/12/2007

distribution between the different certification activities should be identified and agreed with the Agency and/or the appropriate Engine and Aircraft Authorities: (an example is given in paragraph (6)).

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

Aircraft certification should deal with the specific precautions taken in respect of the physical and functional interfaces with the Engine/Propeller.

AMC 20-1 Effective: 26/12/2007

Annex II to ED Decision 2007/019/R of 19/12/2007

6 TABLE

An example of distribution between Engine and Aircraft certification. (When necessary, a similar approach should be taken for Propeller applications).

TASK	SUBSTANTIATION UNDER CS-E	SUBSTANTIATION UNDER CS-25	
		with Engine data	with Aircraft data
ENGINE CONTROL AND PROTECTION	<ul style="list-style-type: none"> - Safety objective - Software level 	<ul style="list-style-type: none"> - Consideration of common mode effects (including software) - Reliability - Software level 	
MONITORING	<ul style="list-style-type: none"> - Independence of control and monitoring parameters 	<ul style="list-style-type: none"> - Monitoring parameter reliability 	<ul style="list-style-type: none"> - Indication system reliability - Independence Engine/ Engine
AIRCRAFT DATA	<ul style="list-style-type: none"> - Protection of Engine from Aircraft data failures - Software level 		<ul style="list-style-type: none"> - Aircraft data reliability - Independence Engine/ Engine
THRUST REVERSER CONTROL/ MONITORING	<ul style="list-style-type: none"> - Software level 	<ul style="list-style-type: none"> - System reliability - Architecture - Consideration of common mode effects(including software) 	<ul style="list-style-type: none"> - Safety objectives
CONTROL SYSTEM ELECTRICAL SUPPLY	<ul style="list-style-type: none"> - Reliability or quality Requirement of Aircraft supply, if used 		<ul style="list-style-type: none"> - Reliability of quality of Aircraft supply, if used - Independence Engine/ Engine
ENVIRONMENTAL CONDITIONS	<ul style="list-style-type: none"> - Equipment protection 	<ul style="list-style-type: none"> - Declared capability 	<ul style="list-style-type: none"> - Aircraft design
LIGHTNING AND OTHER ELECTROMAGNETIC EFFECTS	<ul style="list-style-type: none"> - Equipment protection Electromagnetic emissions 	<ul style="list-style-type: none"> - Declared capability - Declared emissions 	<ul style="list-style-type: none"> - Aircraft wiring protection and electromagnetic compatibility
FIRE PROTECTION	<ul style="list-style-type: none"> - Equipment protection 	<ul style="list-style-type: none"> - Declared capability 	<ul style="list-style-type: none"> - Aircraft design