NOTICE OF PROPOSED AMENDMENT (NPA) No 03/2005

DRAFT DECISION OF THE EXECUTIVE DIRECTOR OF THE AGENCY,

on certification specifications for engines (CS-E)

Miscellaneous amendments to CS-E

CONTENTS

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

A. Explanatory Note

I. General

1. The purpose of this Notice of Proposed Amendment (NPA) is to propose changes to the certifications specifications for engines (CS-E). The reason for this proposal is outlined further below. This measure is included in the Agency's 2004 Rulemaking programme under task number E.001.

2. The text of this NPA was developed by a drafting group set up by the Agency. It is submitted for consultation of all interested parties in accordance with Article 43 of the basic Regulation and Article 6 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.

II. Consultation

3. 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 02 June 2005** 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.

III. Comment response document

4. All comments received will be responded to and incorporated in a so-called Comment Response Document (CRD). This may contain a list of all persons and/or organisations that have provided comments. The CRD will be available two months before the final Agency Decision is made.

[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.

IV. Discussion of the proposals (see section B for the actual proposals)

Proposal 1 (CS-E 130)

The proposed CS-E 135 has retained most of the former text of CS-E 130 (g). Therefore, CS-E 130 (g) can be deleted. This induced a need for re-numbering of sub-paragraphs.

Proposal 2 (CS-E 135)

The history of changes to the "bonding" requirement in engine certification specifications is complex. For a good understanding, it is detailed below.

JAR-E was created on 15 September 1972, based on the British code BCAR Section C, issue 7. It must be noted that JAR-E did not address engines for helicopters before its amendment 6 published on 28 August 1981.

In BCAR section C, issue 7, the text was:

"C3-2, 1.3.8 and C4-2, 1.3.8 : the bonding requirements of Section D, chapter D4-6, shall be complied with."

This paragraph number became 1.3.7 then 1.4.7 in later issues but with same text. JAR 25X.899 replaced BCAR Section D, chapter D4-6 in JAR-E change 7. The latest issue of BCAR Section C as a separate document was issue 13 (basis of JAR-E change 7). (Note: the wording was "amendment" until amendment 6, then it was "change" until change 10, and back to "amendment" for later issues of JAR-E)

In JAR-E at Change 7, the text was as follows:

"C3-2, 1.4.7 : the bonding requirements of JAR 25X899 shall be complied with. C4-2, 1.4.7 : the bonding requirements of the relevant rotorcraft requirements shall be complied with."

Obviously, there were faults in these texts. Indeed, the text for engines to be installed in rotorcraft did not give any clear indication on what were exactly the applicable requirements. For turbofan and turbojet engines, the reference was to large transport aircraft certification requirements (JAR-25) even if the intended installation was a JAR-23 aircraft. When preparing the change 8 of JAR-E, which introduced the new format of this code, some clarification was added but the main goal was simply the change in format, not a full revision of the technical content.

Then, JAR-E at change 8 contained the following:

"JAR-E 530 (g) The bonding requirements of JAR 25X899 or equivalent aircraft requirements shall be complied with."

This was not much clearer for application at the time of engine certification. This text in JAR-E at change 8 was sometimes interpreted as requiring, from the engine designer, a demonstration of compliance of the complete aircraft with its certification requirements. This was obviously not the intent. Then, a revision to the technical content was made by means of NPA-E-8, entitled "Engine fire precautions", which revised JAR-E 530 : the new text was limited to the engine elements to avoid the above noted erroneous interpretation. But the purpose of this NPA was not electrical bonding. The changes to bonding requirements which were made by means of this NPA should be considered as a side effect only.

Then, JAR-E at change 9 contained the following:

"JAR-E 530 (h) Engine components and modules shall be electrically bonded so as to enable the aircraft in which they are installed to show compliance with the applicable aircraft requirements."

This paragraph was further modified by NPA-E-29, entitled "Cross references to aircraft requirements". The purpose was to eliminate, from the engine certification requirements, cross-references to other codes, in order to make JAR-E self contained as far as possible, to be consistent with concepts included in JAR-E 20 (dealing with interfaces) and JAR-E 30 (dealing with assumptions on aircraft installation). Changes to JAR-E 530 (h) were very limited while waiting for NPA-E-24.

Then, JAR-E at change 10 contained the following:

JAR-E 530 (h) Engine components and Modules shall be electrically bonded so as to be compatible with the assumed aircraft installation.

JAR-E at amendment 11 contained the same text.

As a result of the harmonisation of JAR-E 530 with FAR 33.17, NPA-E-24 has deleted JAR-E 530 and replaced it by a new JAR-E 130.

Then, JAR-E at amendment 12 contained the following:

JAR-E 130 (g) Any components, modules, equipment and accessories which are susceptible to or are potential sources of static discharges or electrical fault currents must be designed and constructed so as to be grounded to the Engine reference in order to minimise the risk of ignition in external areas where flammable fluids or vapours could be present.

The same text is now in CS-E 130 (g).

Some elements of JAR 25X.899 have been lost with these changes. The current CS-E 130 (g) is limited to fire ignition sources. The aircraft requirements for electrical bonding are more general and in particular they address the electrical continuity in case of EMI or lightning effects. This was identified by some commenters on NPA-E-24 and JAA agreed to initiate later on a specific rulemaking activity on the subject. A draft NPA-E-56 was then registered. This NPA 03/2005 is consequently the continuation of this effort.

It is being proposed to create a new paragraph CS-E 135 dedicated to Electrical Bonding because it covers more than fire precautions. Wording has been adapted from the current CS-E 130 (g) and CS 25.899.

The phrase "ignition in external areas where flammable fluids or vapours could be present" has been changed to "unintentional ignition in areas where flammable fluids or vapours could be present" to recognise the potential for ignition in areas both internal and external to the engine. "Unintentional" has been added to exclude the intentional ignition within the combustor.

Proposal 3 (CS-E 580)

The original rule was introduced into BCAR section C by Blue Paper 551, dated 15^{th} July 1970.

By JAA NPA-E-40, embodied in amendment 12 of JAR-E, the paragraph that is currently CS-E 580 (b) was modified: the reference to “extremely improbable” was changed into “extremely remote”.

However, at same time, it was agreed that it is unlikely that an extremely remote failure occurrence for a mechanical system such as an air duct can be substantiated. Indeed, as explained in CS-E 510 (a)(3); “extremely remote” is translated into a 10^{-8} figure. To substantiate such a figure with in-service experience would be hardly achievable except in some exceptional cases. An action had been raised to propose further improvement of this paragraph (see the JAA “response to comment” document related to NPA-E-40). This was the purpose of the JAA NPA-E-54.

It was realised that the use of the wording “unsafe engine condition” was not very clear. Considering that the reference was to an extremely remote occurrence, to be consistent with CS-E 510 classification of failure conditions, it was proposed to change this reference into “hazardous engine effect”.

Consequently, there were two options with regard to the reference to extremely remote.

First option. The reference to extremely remote is understood as in CS-E 850 (“shafts”): in the absence of supporting numerical data, design precautions would be required. This would result in classifying a duct as a critical part when it would probably be difficult to justify such a classification. Indeed, although this could be possible, the failure of a duct is unlikely to result by itself (directly) in a hazardous engine effect according to CS-E 515 (engine critical parts) and the associated definitions:

Engine Critical Part	means a part that relies upon meeting prescribed integrity specifications of CS-E 515 to avoid its Primary Failure, which is likely to result in a Hazardous Engine Effect.
Primary failure	means a failure of a part which is not the result of the prior failure of another part or system.

Second option. To delete the reference to an occurrence rate. This would impose a design requirement: no hazardous engine effect after failure of the duct during the flight or before detection by maintenance.

The second option was adopted in JAA NPA-E-54 which was submitted to public consultation. The review of comments and the analysis of the situation led to a different solution: deletion of CS-E 580 (b).

The following provides the detailed rationale for the proposal to delete CS-E 580(b):

It is not clear why the original rule that was introduced by Blue Paper 551 into BCAR was considered necessary and it is unlikely that such evidence will be easily forthcoming. Additionally, developments in other rules and the rigour with which they have been applied to engine ducts have resulted in acceptable service experience with these components.

All air ducting on engines, whether internal or external to the engine and which is part of the engine type design, has been assessed under the analysis required by JAR-E/CS-E 510, meeting the criteria of effects and probabilities prescribed by these certification specifications. Common practice has been to show compliance to JAR-E 510 with reference to this in claiming compliance with JAR-E 580 (b).

Deletion of CS-E 580 (b) would have the benefit of eliminating a difference between CS-E and FAR 33. The effects of failures of air ducts are considered under FAR 33.75 in FAA certification exercises.

There has been service experience of duct failures but none which would not have been addressed under CS-E 510 or CS-E 860 (cases of rupture of cooling tubes). The service experience does not therefore appear to support the continued need for ducts to merit special attention in CS-E 580 (b).

Some clarification has been added to AMC to CS-E 510 to ensure that the effects on the engine of failure of aircraft air ducts are taken into account.

Consequently, it is proposed to delete CS-E 580 (b) and to renumber sub-paragraph (a) and re-title CS E 580.

Proposal 4 (CS-E 1030)

The content of current paragraph CS-E 1030, coming from the JAA NPA-E-47 which was worldwide circulated for comments by JAA, has been considered by one commenter to be too vague for being useful as a rule. The commenter was of the opinion that all relevant certification specifications for this activity would likely be found in some policy paper or in some advisory material. Indeed, FAA has published a “policy for time limited dispatch of engines fitted with full authority digital engine control systems”.

This commenter proposed to further change CS-E 1030. This was accepted by JAA for future rulemaking and the proposal was registered as a draft JAA NPA-E-55.

This NPA 03/2005 has taken account of this discussion and proposes clearer certification specifications for time limited dispatch conditions as far as the engine is concerned. This would reduce the risk of unequal treatment or of arbitrary decisions.

This explanatory note addresses both Proposal II.4 (CS-E 1030) and Proposal II.11 (AMC to CS-E 1030).

History

Initial Electronic Engine Control System (EECS) reliability analyses were essentially based on full-up system configurations; these analyses provided little information in the area of system integrity with faults present. As a result, dispatch criteria for the early EECSs entering revenue service was determined by the selection criteria used when establishing the aircraft’s Master Minimum Equipment List (MMEL). This criterion follows the traditional path of considering the consequences of the next failure. Due to the complexity of EECSs, it was difficult to consider the various failure combinations and the consequences of the next failure. There was little or no supporting safety analysis or field experience on which to base a dispatch decision. This resulted in somewhat limited dispatch criteria that, in some cases, had a more negative impact on the aircraft delay and cancellation performance than might result from an analysis performed according to the proposed CS-E 1030.

Aircraft and engine manufacturers recognized that the redundancy features and reliability of the EECSs could provide a means for improving (that is, reducing) aircraft delay and cancellation events by enabling redundant systems to dispatch with faults present. The EECSs would also improve control system reliability compared to the technology they replace. The dispatch configurations would have to meet engine and aircraft airworthiness standards and demonstrate that the use of non-full-up dispatch configurations would be acceptable over a specified dispatch interval. The manufacturers proposed time limited dispatch (TLD) intervals that would enable aircraft to complete their regularly scheduled route structure. The EECS faults could then be repaired on a normal maintenance schedule for the aircraft. Over the years, engine and aircraft certification authorities and flight standards groups have agreed on an approach to TLD approval and operations.

Rates and Limits

As detailed in draft AMC 20-3, the 10 per million average loss of thrust control/loss of power control (LOTC/LOPC) rate that was applied to the total system was based on a historic rate of several earlier hydromechanical systems on turbine engines. For the rates associated with the time limited configurations, no known rates were available.

For the short time dispatch interval, the maximum allowable LOTC/LOPC rate(with fault present) for engines installed on CS-25and most other aircraft that have a fleet-wide average LOTC/LOPC rate for less than 10 per million (see draft AMC 20-3), was set as 100 per million. This means that for a limited time the system is at worst a 10,000-hour mean-time-to-failure system.

This has proven to be sufficient based on the fleet statistics over the last 15 years. These rates have been a standard for the SAE E-36 Electronic Engine Controls committee since June of 1997, and were published in ARP5107. The document was significantly revised in 2004 and the recommended LOTC/LOPC rate did not change.

However, in the CS-23 aircraft where the fleet-wide average LOTC/LOPC rate is set at less than 45 failures per million engine flight hours, the short time dispatch configuration limit is 450 failures per million flight hours.

These time limits are quite conservative and were selected for initial applications where no in service experience is available. These have proven to be quite satisfactory, safe, and non-burdensome to the operators. In several cases where initial in-service difficulties were encountered, the shorter time periods proved successful.

Approvals and Methods

The approach to TLD approval is appropriate because the EECS is not considered “inoperative” when operating with its various system related faults; the system merely loses some of its redundancy. The following factors suggest that the EECS does not readily fit the traditional definition of an inoperative system, as addressed by an aircraft MMEL :

- A maintenance procedure pertinent to TLD is not required before releasing the aircraft for service;
- There is usually no operational impact on crew procedures; and
- Generally, an aircraft performance penalty does not need to be applied before releasing the aircraft for service.

This approach to TLD approval retains the authority for the initial approval of EECS TLD operations under engine certification. The implementation of the maintenance activities required under TLD is done through the operator's MEL and/or the operator's maintenance plan for the aircraft.

In early TLD applications, EECSs were listed in the aircraft's MMEL. The reason for this is as follows: The operators did not want any maintenance tasks that were more frequent than an aircraft "A" check. Initial aircraft "A" checks are generally between 250 and 400 hours. The initial periodic inspection for EECS short time faults - for entry-level EECSs - was set at 150 flight hours or 10 calendar days, whichever occurred first. Since this is a shorter time interval than the aircraft "A" checks, the operators wanted an indication on the flight deck that a short time fault condition was present. The operators used the indication to "start the clock" and schedule the appropriate repair(s). Since the flight crew would see the indication, a means to allow dispatch with the indication present became necessary. Thus, an item to address the indication and allow dispatch with short time EECS faults present was added to the MMEL. However, it is acceptable to not have any flight deck indications for EECS short time or long time faults. If an operator prefers, EECS short and long time faults may be addressed using a Periodic Inspection/Repair Maintenance Approach.

The TLD AMC lists specific criteria for entry-level EECS TLD approval. The short time dispatch interval (time limitation) for entry-level applications has been established as "125 flight hours." This was prompted by operator request. TLD operations are being implemented and becoming a standard for small operators and business aircraft operations in addition to transport operations. For small operators and business aircraft operations, the earlier use of a 10-calendar days requirement was considered overly restrictive.

Experience has shown that the tracking of the in-service LOTC/LOPC rate data provides a clearer indication of the maturity of a system than the earlier approach using a fixed number of hours of service time in engine flight hours. However, for large transport aeroplanes, experience has also shown that the maturity does not usually come much before 1,000,000 engine flight hours. The airworthiness authorities will consider applications for extending the TLD short and long time limitations when field service data supports the request.

In paragraph (5) of AMC to CS-E 1030, the publication of a summary report has been called out in order to comply with the proposed CS-E 1030 (b)(8). This avoids a problem that a number of applicants have had, with earlier call out to reference the TLD LOTC/LOPC Analysis Report. Operators have frequently requested this reference report and the applicant has been reluctant because the full report is considered to be proprietary to the applicant. Thus it is being recommended that a summary report be produced and made available. The applicants have been encouraged to include a statement in the installation manual that tells the installer that they must work closely with the engine manufacturer if the installer is going to place more restrictive limitations, either time or functionality or elements, on TLD.

Proposal 5 (AMC to CS-E 30)

An error has been identified in CS-E: two entries in table 1 of AMC to CS-E 30 refer to CS-E 530 which no longer exists. This has been corrected in this NPA together with the necessary changes linked to introduction of the new CS-E 135.

Proposal 6 (AMC to CS-E 60 (d))

During some certification programmes for engines that have 30-Second / 2-Min OEI ratings, it became apparent that there was some confusion as to whether any use of a 20 Second Maximum Engine Over-Speed, Over-Torque or Over-Temperature should be recorded as a usage of the 30-Second/2 Minute Power Ratings. The purpose of this proposal is therefore to provide clarification on this matter.

There is a fundamental difference between the over-speed, over-torque and over-temperature requirements, and the 30-Second/2-Minute rating.

The Over-speed etc. requirements are there to allow an applicant to claim credit where an engine has a demonstrated capability of sustaining such an event without damage that would compromise its safe continued operation. Approval of such over-speed, etc limits does not influence the approved performance of the aircraft: it is a means to validate the instructions for continued airworthiness (here: no maintenance action).

The 30-Second/2-Minute Rating is exactly what it says: a rating, and it is clearly important that appropriate tests are conducted to demonstrate that the engine can deliver this rated power throughout its in-service life (e.g., time between overhauls). These ratings affect the aircraft performance and are associated with mandatory maintenance actions.

The maximum engine over-torque, maximum engine over-speed and maximum exhaust gas over-temperature limits are validated according to CS-E 820, E 830, and E 870 respectively; inadvertent excursion within this 20-second limit does not require maintenance actions. Clearance of such over-speed, over-torque and over-temperature has been applied equally for many years across all engine types (turbofan, turboshaft, etc.), whatever their rating structure, and experience has shown that the methodology underlying the clearance of these limits is robust.

It has been agreed that where the recording system is also able to determine that the engine is exceeding its normal operating limits whilst in an all engine operating condition, this need not be recorded as a usage of 30-second OEI when the exceedence is within any limit approved under CS-E 820, 830 or 870.

The new AMC proposes that such events are allowed within the validated limits and need not be recorded as OEI usage subject to 2 conditions: 1) that the event occurs in an "all engines operating" condition, 2) that OEI power availability is not compromised.

The issue of cumulative damage, from the occurrence of several such events, on 30sec/2min OEI power availability (in practise a limited number) has been considered. CS-E already requires showing availability of 30sec/2min OEI power at any time. The proposed text draws attention to the need to ensure that exposure to an over-speed or over-temperature etc. condition does not compromise the engine's ability to develop this rated power. The means of demonstrating this is left to the applicant.

The text of CS-E 60 (d)(1) refers to “when the event begins” : this is clearly related to the usage of the 30-Second/2 Minute ratings. Therefore, the proposal II.6 is an interpretation of what constitutes an event for compliance with CS-E 60.

Proposal 7 (AMC to CS-E 130)

The intent of the text in sub-paragraph 5(c) of the current AMC has been transferred to AMC to CS-E 135 so that all the advisory material relating to electrical bonding is in one place. The paragraphs in AMC to CS-E 130 have been renumbered.

Proposal 8 (AMC to CS-E 135)

This proposal incorporates the intent of what was in paragraph (5)(c) of current AMC to CS-E 130 with any necessary guidance for the new CS-E 135.

It has been agreed that additional detailed advisory material would be of value to the specialists who will be involved in this issue. There are no recognised industry standards currently published in relation to electrical bonding. If and when such recognised industry standards become available, this AMC should be reviewed.

Proposal 9 (AMC to CS-E 170)

This proposal has been introduced to assure that the electrical bonding provisions used in the lightning tests are consistent with the type design.

Proposal 10 (AMC to CS-E 510)

This proposal has been introduced as a reminder of the need to address the effect of aircraft air duct failures. See also justification for the proposal II.3.

Proposal 11 (AMC to CS-E 1030)

New AMC has been proposed in relation to the new proposed text of CS-E 1030. See the explanatory note on Proposal II.4 (CS-E 1030).

Proposal 12 (cross references to AMC 20 documents)

Because of the new (still draft) AMC 20-3, cross references to the AMC 20 documents that could be found in CS-E needed correction. This is purely editorial.

Proposal 13 (table of contents)

This proposal is purely editorial, for consistency with the other changes proposed in this NPA.

V. Harmonisation with non-EU texts

Proposal 1 (CS-E 130)

This is a change to the text which was agreed as part of the FAA/JAA harmonisation programme. However, FAR 33 has not yet been amended to reflect the previously “harmonised” text. Therefore, this NPA 03/2005 does not affect the harmonisation status of this subject as it is in the published FAR 33 and CS-E.

Proposal 2 (CS-E 135)

There is no equivalent paragraph in FAR 33. The proposal retains the intent of current CS-E 130 (g) and re-introduces specifications which are currently found in aircraft codes.

Proposal 3 (CS-E 580)

The deletion of current CS-E 580 (b) improves the harmonisation by deleting a formal difference. The US and European current practices in relation to failure of ducts are similar.

Proposal 4 (CS-E 1030)

The initial issue of CS-E contains a paragraph CS-E 1030 that has no counterpart in FAR 33. Then, formally, FAR33 and CS-E are not harmonised. Nevertheless, this proposal is based mainly on the current FAA policy and therefore it is considered that this proposal provides some harmonisation with the current practice in the USA.

Proposal 5 (AMC to CS-E 30)

There is no equivalent to CS-E 30 in FAR 33. As a consequence, this proposal does not affect the harmonisation status of CS-E and FAR 33.

Proposal 6 (AMC to CS-E 60 (d))

This proposal clarifies the interrelationship between CS-E 60 (d) and CS-E 820, 830 and 870. There is no equivalent to CS-E 820, 830 and 870 in FAR 33. As a consequence, this proposal does not affect the harmonisation status of CS-E and FAR 33.

Proposal 7 (AMC to CS-E 130)

The intent of the deleted part has been addressed in AMC to CS-E 135. Thus the harmonisation status is not affected.

Proposal 8 (AMC to CS-E 135)

There is no equivalent advisory material for FAR 33. The proposal retains the intent of current AMC to CS-E 130 and adds guidance which addresses the new specifications in CS-E 135.

Proposal 9 (AMC to CS-E 170)

There is no equivalent advisory material for FAR 33.

Proposal 10 (AMC to CS-E 510)

Effects of failure of air ducts are considered under FAR 33.75 in US certification exercises. This proposal reflects current practice and does not change the harmonisation status of CS-E and FAR33.

Proposal 11 (AMC to CS-E 1030)

See justification for Proposal 4.

Proposal 12 (cross references to AMC 20 documents)

Being purely editorial, this proposal does not affect the harmonisation status of CS-E and FAR 33.

Proposal 13 (table of contents)

Being purely editorial, this proposal does not affect the harmonisation status of CS-E and FAR 33.

VI. Regulatory Impact Assessment

Intent of the NPA:

The intent is to clarify some of the certification specifications of CS-E in order to facilitate their application and interpretation during engine certification.

Options

The alternative option would be to do nothing but this would not provide the necessary clarification of the texts.

Sectors affected

The industry sectors affected are the designers of engines or others using CS-E as the basis of certification.

The Agency will not be affected.

The National Aviation Authorities will not be affected.

Impacts

Safety: The intended changes are not expected to have a negative impact on safety. This NPA does not introduce any changes that are considered materially to affect the level of safety in the context of Part 21, paragraph 21A.101 (b)(3).

Economic: Most of the proposed changes are intended to clarify the wording of CS-E and its interpretation. It is assumed that these new certification specifications will not impose a change in existing engine designs. By taking away some possible ambiguities and incorporating existing policies and thus improving legal certainty they should facilitate an easier and more efficient implementation.

The most significant change which is being proposed, related to approval of time limited dispatch engine configuration, is based on existing policies. This might however induce some additional work for the applicants or a change in some past procedures but this is not totally new. Furthermore, as noted in CS-1000, declaration of a time limited dispatch engine configuration, and consequently the use of CS-E 1030, is an option left to the decision of the applicant itself.

Therefore, a limited positive economic impact is anticipated.

Environmental: The proposals will not have an impact on the environment.

Social: The proposals are not expected to have a social impact.

Other aviation requirements: No impact on aviation requirements outside the EASA scope is expected. See the status on harmonisation with non-EU texts in paragraph V. above.

Conclusion of the Regulatory Impact Assessment

Based on this RIA, the proposals of this NPA 03/2005 are considered as having no safety, social or environmental impact, and a slightly positive economic impact. Therefore the progress of the proposals is justified.

B. PROPOSALS

The following amendments to Decision No. 2003/9/RM of the Executive Director of the Agency of 24 October 2003 (CS-E) are proposed:

Proposal 1. To delete current sub-paragraph (g) of CS-E 130 and to re-number sub-paragraph (h) as (g)

Proposal 2. To create a new paragraph CS-E 135 to read as follows:

CS-E 135 Electrical Bonding

Any components, modules, equipment and accessories that are susceptible to or are potential sources of static discharges or currents from electrical Faults, must be designed and constructed so as to be grounded to the main Engine earth, as necessary to minimise the accumulation of electro-static or electrical charge that would cause:

- Injury from electrical shock,
- Unintentional ignition in areas where flammable fluids or vapours could be present,
- Unacceptable interference with electrical or electronic equipment.

Proposal 3. To delete current sub-paragraph (b) of CS-E 580 and change the title and lay-out so that CS-E 580 reads as follows:

CS-E 580 Air Systems

Where bleed air is used to cool or to pressurise areas of the Engine the functions of which could be detrimentally affected by the ingress of foreign matter (e.g. sand or dust) the design must be such that the passage of foreign matter of unacceptable quantity or unacceptable size is precluded.

Proposal 4. To modify current paragraph CS-E 1030 to read as follows:

CS-E 1030 Time Limited Dispatch

(a) If approval is sought for dispatch with Faults present in the Electronic Engine Control System (EECS), a time limited dispatch (TLD) analysis of the EECS must be carried out.

(b) For each dispatchable configuration the analysis must show that:

(1) The Engine remains capable of meeting all CS-E specifications for -

(i) Operability aspects (e.g., acceleration, starting, freedom from surge or stall);

(ii) Re-light in flight;

(2) The ability to control the Engine within limits is maintained;

(3) Protection is maintained against Hazardous Engine Effects, if provided by the Engine Control System and shown to be necessary by the safety analyses required under CS-E 510 and CS-E 50

(4) A means is maintained to provide necessary signals to identify system Faults;

(5) A further single Failure in the Engine Control System will not produce a Hazardous Engine Effect;

(6) The Engine continues to meet its certification specifications for external threats (e.g. rain, hail, bird, high intensity radiated fields (HIRF) and lightning);

(7) The time-weighted-average of the Full-up Configuration and all allowable dispatch configurations with Faults, meets the Loss of Thrust/Power Control (LOTC/LOPC) rate for the intended application(s);

(8) The proposed dispatch intervals are justified. The periods of time allowed prior to rectification of Faults must be substantiated as part of the LOTC/LOPC analysis and these times must be documented in the appropriate manual(s).

(c) Provision must be made for any no-dispatch configuration to be indicated to the flight crew.

Proposal 5. To delete the two entries related to CS-E 530 in table 1 of AMC to CS-E 30 and to add in this table the following new entries:

AMC to CS-E 30

Fire precautions CS-E 130	Reliance placed on installation fire-zone partitioning for any part of the mounting structure or Engine attachment points that are not Fireproof.
Electrical bonding CS-E 135	Reliance placed on Aircraft provisions for electrical bonding of the Engine

Proposal 6. To add a new paragraph (5) to the current AMC to CS-E 60 (d) to read as follows:

AMC to CS-E 60 (d)

(5) An Engine can be approved with 30-Second/2-Minute OEI Power Ratings and any combination of Maximum Engine Over-torque, Maximum Engine Over-speed and Maximum Exhaust Gas Over-Temperature in compliance with CS-E 820, 830, and 870. In such a case, Engine operation above the Take-off Rating limits but within the limits established under CS-E 820, 830, and 870 need not be recorded as usage of 30-Second/2-Minute OEI Power Ratings if the event was a true over-torque, over-speed or over-temperature event and it can be demonstrated that the recording system is able to distinguish between;

- an Engine over-speed, over-torque or over-temperature with all Engines operating, and
- use of the 30 Second/2 Minute OEI Power Ratings with one Engine inoperative.

It should be shown that an over-speed, over-torque or over-temperature event does not compromise the ability of the Engine to reach its Rated 30-Second/2-Minute OEI Power.

Proposal 7. To modify title of paragraph (5) of current AMC to CS-E 130, to delete sub-paragraph (5)(c) and to re-number other sub-paragraphs of current paragraph (5) as new paragraphs (6) to (9) so that AMC to CS-E 130 reads as follows:

AMC TO CS-E 130

(5) Flammable fluid tank fire test

In the absence …. (no change in this paragraph)

(6) Drain and Vent Systems

CS-E 130 (b) allows … (no change in this paragraph)

(7) Air Sources

In accordance with CS-E 130 (a), the applicant … (no change in this paragraph)

(8) Firewall

The overall intent of CS-E 130 (d)(2) is to … (no change in this paragraph)

(9) Shielding

The overall intent of CS-E 130 (b) specification … (no change in this paragraph)

Proposal 8. To create a new AMC to CS-E 135 to read as follows :

AMC TO CS-E 135

Electrical Bonding

Electrical bonding is a means to protect against the effects of electro-static discharges and currents from electrical Faults. The overall intent of CS-E 135 is to ensure that

- a main Engine earth is provided. This is generally achieved by showing that all the elements of the Engine carcass are electrically bonded together.
- a current path for electrical bonding exists between certain components that are mounted externally to the Engine and the main Engine earth.

With respect to the accumulation of electro-static or electrical charge, the applicant should show that the modules, assemblies, components and accessories installed in or on the Engine are electrically bonded to the main Engine earth. This may be accomplished by examination of the type design drawings, electrical continuity checks, or actual inspection of a representative Engine.

Proposal 9. To add a new paragraph to AMC to CS-E 170 (following the fifth paragraph) to read as follows :

AMC to CS-E 170

…can be found in AMC to CS-E 80.

If, for compliance with CS-E 170, high intensity radiated fields (HIRF)/ Lightning tests are carried out on anything other than a representative complete Engine, the test results may depend on the validity of the assumed electrical bonding between those elements of the Engine that are tested and the main Engine earth. In such cases, the applicant should demonstrate that these electrical bonding assumptions are valid. This may be accomplished by examination of the type design drawings, electrical continuity checks, or actual inspection of a representative Engine.

For compliance with CS-E 170….

Proposal 10. To change the second sub-paragraph of (3)(c) in AMC to CS-E 510 to read as follows :

AMC to CS-E 510

CS-E 510 (f) requires the applicant to include in the Engine safety analysis consideration of some Aircraft components. For example, under CS-E 510 (f)(3) the effects on the Engine of Failure of Aircraft air ducts might be considered.

Proposal 11. To create a new AMC TO CS-E 1030 to read as follows :

AMC to CS-E 1030

Time limited dispatch

(1) Guidance

This AMC provides guidance for obtaining type design approval of engines with EECS in a degraded condition with respect to redundancy when these systems are to be dispatched with Faults present for limited time intervals before maintenance actions are required. This is commonly referred to as time limited dispatch (TLD).

The objective of TLD is to allow dispatch with certain EECS faults present but without them compromising the prescribed fleet-wide average LOTC/LOPC rates.

TLD methodology is one way of managing dispatch with EECS Faults. Faults in systems or equipment other than EECS or, Faults other than loss of redundancy are typically addressed through the Master Minimum Equipment List (MMEL).See also paragraph (7) below.

TLD operations have been applied to EECS-equipped engines used in multi-engine Aircraft applications, particularly those engines used in large transport Aeroplanes (certified under CS-25). The TLD requirements and limitations for those multi-engine Aircraft discussed in this advisory material should be acceptable in single engine Aircraft applications. However, the criteria used to establish acceptable TLD operations may need to be reviewed for those other applications. This assessment of control system reliability and availability requirements for single engine Aircraft applies to both reciprocating and turbine engines. The Engine Control System reliability and availability requirements should be the same for both turbine and reciprocating engines when those engines are targeted for the same type of Aircraft application.

(2) Definitions

Definitions may be found in CS-Definitions, CS-E 15 and AMC 20-3. For the purpose of this AMC to CS-E 1030 the following additional definitions apply.

"Average Fault Exposure Time" means the duration of time that the average system is exposed to a Fault before periodic inspection/ repair is performed. It applies when the periodic inspection/repair maintenance approach is used. In this case the time of occurrence of the Fault may not be known.. One-half of the periodic inspection interval will be used since the Fault could have occurred at any time during the interval. This assumes that the Fault rate of occurrence is constant throughout the interval. If the Fault rate is not constant throughout the interval, the average exposure time should be adjusted accordingly.

"Dispatch Interval" means the maximum time interval approved for dispatch with Faults present in the system before corrective maintenance is required.

(3) Referenced Documents

ARP 5107, Time-Limited-Dispatch (TLD) Analysis for Electronic Engine Control Systems

SAE World Headquarters, 400 Commonwealth Drive, Warrendale, PA 15096-0001, USA.

(4) Time Limited Dispatch Analysis

The TLD analysis should define the dispatchable configurations in terms of the Faults and their associated dispatch intervals. To substantiate that the reliability goal for the EECS under TLD operations can be achieved, the applicant should show by a suitable analysis, typically a Markov analysis or Fault tree analysis, that the fleet-wide average reliability criteria or "average LOTC/LOPC rate," which includes full-up as well as degraded system dispatches and Uncovered Faults, meets the LOTC/LOPC rate for the assumed installation (see also AMC 20-3).

The analysis to substantiate compliance with a given LOTC/LOPC target should be summarised in a graph. An example of such a graph is shown in Figure 1. The ordinates of the graph should be the estimate of fleet-wide average LOTC/LOPC rate of the EECS versus the dispatch interval(s) (in hours) for the EECS Faults

If dispatchable EECS Faults have been grouped into two categories, a short-time dispatch (or repair) category and a long time dispatch (or repair) category (see paragraph (6) below), the ordinate of the graph should show a long time dispatch time interval of at least twice the length of time of the repair interval being requested. When calculating the LOTC/LOPC rate as a function of the long time interval, the assumed short-time interval should be twice the requested short-time interval. This factor of two is used to cover uncertainties in the analysis itself.

In the analysis, all Uncovered Faults should be assumed to lead to LOTC/LOPC unless it can be shown that they do not directly result in an LOTC/LOPC. The analysis should provide the rationale and substantiation for the Failure rates used for Uncovered Faults in the analysis.

(5) Certification specifications for all dispatchable configurations.

CS-E 1030 (b)(1) through (b)(8) prescribe the requirements for all dispatchable configurations.

CS-E 1030 (b)(5) stipulates that when dispatching with single or multiple Faults, there can be no further single Failure in the Engine Control System that would create a Hazardous Engine Effect. For example, it is necessary to ensure that the over-speed protection system function is operational at dispatch to guard against a Hazardous Engine Effect resulting from a single additional Fault driving fuel flow upwards.

CS-E 1030 (b)(6) requires that the applicant shows that the Engine, in all dispatchable configurations, continues to operate satisfactorily in the external threat levels for the system and remain compliant with the corresponding certification specifications. The Engine in each permitted TLD configuration should maintain the capability of operating through the threats considered during Engine certification: rain, hail, birds, high intensity radiated fields (HIRF) and lightning.

Relative to HIRF and lightning, compliance is typically, but not always, addressed by conducting the tests in the worst-case dispatchable configuration. This worst case is often represented by single channel operation. The other external threats are typically addressed by analysis.

In showing compliance with CS-E 1030 (b)(8), justification of the proposed dispatch intervals should be based on a statistical analysis.

The approved TLD operating limitations should be declared in the manuals specified in CS-E 20 (d) and CS-E 25 (a), whichever is appropriate, and provided to operators as required by Part 21A.61. The approved TLD operating limitations are the times allowed for rectification of Faults. An example of the typical operating limitations for TLD is provided in Table 1 The fact that the Engine has been approved for TLD operations should be recorded in the Engine TCDS (See CS-E 40(d)).

A Summary Report of the Engine Control System time-limited-dispatch analysis should be prepared and made available to the installer. This report should contain the list of the non-dispatchable and time limited dispatch configurations.

The collecting system required by Part 21A.3 (a) should include a means to monitor the in-service LOTC/LOPC rate. This system should compare service experience of component failures with the modes, effects, rates, and exposure times predicted in the TLD analysis. The data collected by this system may be used to support applications for changing dispatch time intervals.

Entry level and mature level EECSs are differentiated to consider factors not included in a reliability analysis.

A mature level system is an EECS that has achieved a stable in-service LOTC/LOPC rate that meets the Loss of Thrust/Power Control (LOTC/LOPC) rate for the intended application and is consistent with the analysis on which TLD approval is based. For engines installed in large transport aeroplanes this might not be achieved until 1,000,000 Engine flight hours in-service operation have been accumulated.

An EECS is classified as an entry-level system if it is not a mature level system.

The applicant may request alleviation from entry level classification if it has sufficiently similar systems operating in the field that have accumulated enough flight hours to establish stable behaviour over time. Such applications will be reviewed on a case-by-case basis.

A reliability analysis is typically based on electronic component databases. These databases consider components to be mature and, hence, only random Failures are considered. Failures due to design, manufacturing, quality and operating environment of the EECS, as well as maintenance errors, are not included.

Since such failures due to design, manufacturing, quality and operating environment of the EECS, as well as maintenance errors, are not covered by the reliability analysis, and because these Faults tend to be exposed and corrected only as in-service time is accumulated, the EECS is classified as an entry-level system and appropriate limitations are applied as shown in Table 2. Thus, more conservative criteria for dispatch intervals for entry-level systems are applied compared to mature level systems, even though the statistical analysis may support dispatch for a longer dispatch interval for entry-level systems.

The TLD analysis report should include a tabulation of the various proposed dispatch configurations and provide: (1) the expected frequency of occurrence of the Faults leading to those dispatchable configurations; and (2) the LOTC/LOPC rate of the system when operating in those configurations.

The report should tabulate the chosen category for each Fault covered in the analysis and show that the exposure time chosen for the short and long time Fault categories allows the EECS to continue to meet its reliability requirements.

(6) Dispatch Categories

The dispatch intervals determined in compliance with CS-E 1030 (b)(8) are usually grouped into dispatch categories.

The following are typical dispatch categories:

(a) No Dispatch. Configurations that do not comply with CS-E 1030 (b) or do not qualify for another category should be categorised as No Dispatch.

(b) Short Time Dispatch. Configurations that comply with CS-E 1030 (b) and satisfy the following condition should be categorised as Short Time Dispatch: the computed LOTC/LOPC rate with the Fault(s) present is less than or equal to an upper limit that has been set at 10 times the fleet-wide average reliability criteria or “average LOTC/LOPC rate” for the installation. (The LOTC/LOPC rates for different installations may be found in AMC 20-3.)

However, even if the Long Time Dispatch LOTC/LOPC rate is met, configurations where the EECS has reverted to essentially single channel operation or has lost a significant degree of redundancy should be categorised as Short Time.

(c) Long Time Dispatch. Configurations that comply with CS-E 1030 (b) and satisfy the following condition should be categorised as Long Time Dispatch: the computed LOTC/LOPC rate with the Fault(s) present is less than or equal to 75 percent of an upper limit that has been set at 10 times the fleet-wide average reliability criteria or “average LOTC/LOPC rate” for the installation. (The LOTC/LOPC rates for different installations may be found in AMC 20-3.)

(d) Applicant defined dispatch. This category is for Faults that do not have an impact on the LOTC/LOPC rate. These Faults do not have to be included in the LOTC/LOPC analysis. It should be substantiated that these Fault conditions do not have an impact on the LOTC/LOPC rate. These configurations should be included in the TLD summary report to enable an appropriate maintenance programme to be developed.

(7) TLD Operations Associated with the “MEL Maintenance Approach” and with the “Inspection/Repair Maintenance Approach.”

The dispatch intervals for Short Time and Long Time dispatch will also depend upon the approach used in the maintenance programme. Where a “MEL” approach is used, and hence the time of initial occurrence of the Fault is known, the dispatch interval starts from the moment the Fault occurs. In the “Inspection/Repair maintenance approach, the Fault is assumed to have occurred half-way through the inspection interval and the dispatch interval is therefore assumed to have started accordingly from this mid-point. In each case, the analysis should support the dispatch interval(s). Table 3 shows a comparison of the maximum operating times for TLD Operations Associated with the “MEL Maintenance Approach” and with the “Inspection/Repair Maintenance Approach.”

Table 1. Typical Operating Limitations for TLD

<table>
<tr><td colspan="2">This page gives the EASA-approved time limits to operate this engine (identify engine manufacturer and model) with control system Faults present. These limits are also defined in engine report (identify report number and date), the Engine Control System Time-Limited-Dispatch Summary Report.</td></tr>
<tr><td>Fault Category</td><td>Operational Limitation</td></tr>
<tr><td>NO DISPATCH</td><td>DISPATCH NOT ALLOWED WITH THIS CONDITION PRESENT.
Note 1: There must be a flight deck display of the presence of a no dispatch condition</td></tr>
<tr><td>SHORT TIME</td><td>DISPATCH IS ALLOWED WITH SHORT TIME FAULTS PRESENT. THE MAXIMUM (AVERAGE – IF APPLICABLE) EXPOSURE TIME OF THE SYSTEM TO THESE FAULTS MUST BE LIMITED TO (insert XXX) FLIGHT HOURS.

Note 2: All Faults in this short time category must be corrected within a time period, such that (a) each Fault in the group does not have an exposure time greater than (insert XXX) hours, OR (b) the average exposure time for short time Faults does not exceed (insert XXX) hours. Also, it is noted that the time limitations contained herein with respect to short time EECS Faults may only be changed with approval of the agency.

• If an MEL Maintenance Approach is used for this Fault category, there should be an appropriate generic flight deck display of the presence of a short time Fault condition(s).
• If a Periodic Inspection/Repair Maintenance Approach is used, the system should be inspected for short time Faults at an interval, such that if Faults are found, they can be repaired so that the average length of time that a Fault is present in the system (average exposure time) does not exceed the specified (insert XXX) hour limitation.

Reference SAE ARP5107 for a more complete understanding of these maintenance approaches.</td></tr>
<tr><td>LONG TIME</td><td>DISPATCH IS ALLOWED WITH LONG TIME FAULTS PRESENT. THE MAXIMUM (AVERAGE – IF APPLICABLE) EXPOSURE TIME OF THE SYSTEM TO THESE FAULTS MUST BE LIMITED TO (insert YYY) FLIGHT HOURS.

Note 3: All Faults in this long time category must be corrected within a time period, such that (a) each Fault in the group does not have an exposure time greater than (insert YYY) hours, OR (b) the average exposure time for long time Faults does not exceed (insert YYY) hours. Also, it is noted that the time limitations contained herein with respect to long time Electronic Engine Control System Faults may only be changed with approval of the agency.

• If an MEL Maintenance Approach is used for this Fault category, there should be an appropriate generic flight deck display of the presence of a long time Fault condition(s).

• If a Periodic Inspection/Repair Maintenance Approach is used, the system should be inspected for long time Faults at an interval, such that if Faults are found, they can be repaired so that the average length of time that a Fault is present in the system (i.e., average exposure time) does not exceed the specified (insert YYY) hour limitation.</td></tr>
</table>

Table 2. Maximum Operating Times for TLD Operations.

Limitations on Electronic Engine Control System Operations with Faults Present

Experience Level	No Dispatch Category	Short Time Faults Category - maximum operating time	Long Time Faults Category – maximum operating time	Electronic Engine Control System Faults Not Affecting the LOTC/LOPC Rate
Entry Level	No Flight Allowed	125 engine flight hours.	250 engine flight hours.	(2)
Mature Level	No Flight Allowed	(1)	(1)	(2)

(1) Times vary depending upon the results of the TLD Analysis.
(2) The time to repair should be included in an appropriate document.

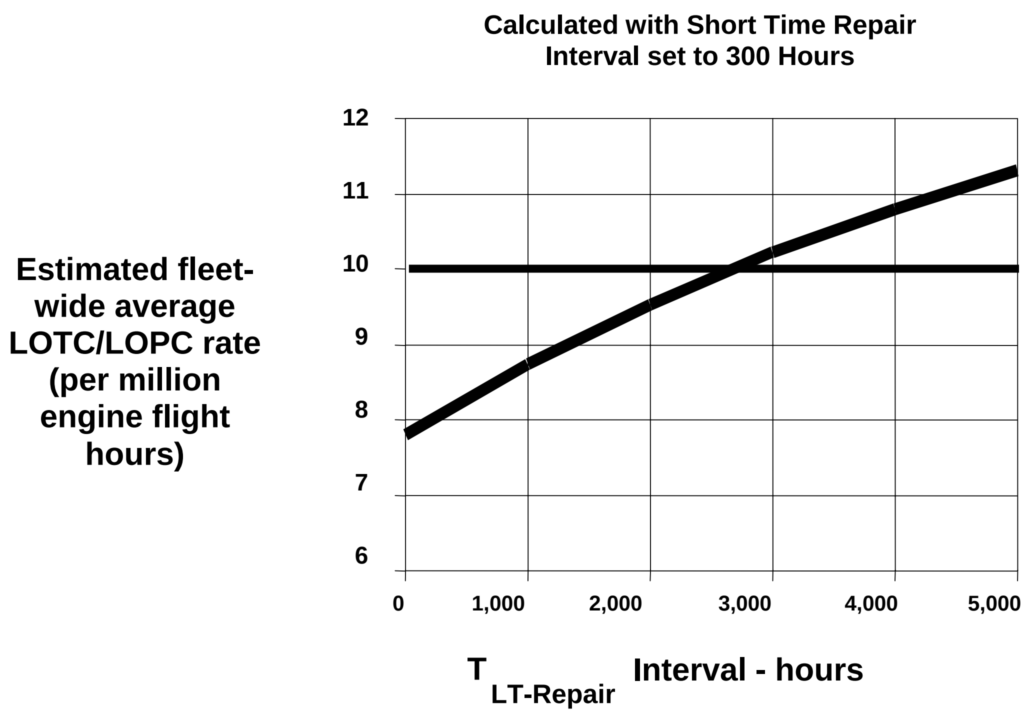
Table 3. Maximum Operating Times for TLD Operations Associated with the “MEL Maintenance Approach” and “Inspection/Repair Maintenance Approach.”

Limitations on Electronic Engine Control System Short Time and Long Time Operations with Faults Present

	Short Time Faults		Long Time Faults	
Experience Level	Time of Fault occurrence known and MEL Maintenance Approach Used – max operating time with Fault(s) present	Time of Fault occurrence unknown and Periodic Inspection/ Repair Maintenance Approach Used – max periodic inspection/repair interval	Time of Fault occurrence known and MEL Maintenance Approach Used – max operating time with Fault(s) present	Time of Fault occurrence unknown and Periodic Inspection/ Repair Maintenance Approach Used – max periodic inspection/repair interval
Entry Level	125 engine flight hours.	250 engine flight hours.	250 engine flight hours.	500 engine flight hours.
Mature Level	(1)	(1)	(1)	(1)

(1) Times vary depending upon the results of the TLD Analysis.

<u>Figure 1. Example of the analysis results for a system with both Short Time Dispatch and Long Time Dispatch</u>



In this example,

- The analysis was conducted with the Short Time repair interval set to 300 hours based on the assumption that the desired Short Time approval was 150 hours. This ratio is in accordance with paragraph (4)
- The target LOTC / LOPC rate is 10 per million engine flight hours
- The analysis shows that the target rate is not exceeded with Short Time set to 300 hours and the Long Time less than 2700 hours. However, the long-time interval would be limited to an operational time of 1,350 hours. Again this ratio is in accordance with paragraph (4).
- In the case of an entry level system the short-time Fault category would be limited to an operational time period of 125 hours, and Faults in the long-time interval would be limited to an operational time of 250 hours. This is in accordance with Table 2.
- If the long-time Faults were to be addressed using the periodic inspection/repair approach, the inspection/repair interval could not be longer than 500 hours for entry level system and 2,700 hours for a mature level system. This in accordance with Table 3.

Proposal 12. To modify cross-references to AMC 20 documents according to NPA to AMC 20 (NPA AMC1/2004).

In AMC to CS-E 50, to replace “AMC 20-1” by “AMC 20-1 and AMC 20-3” in sub-paragraphs (2) and (4).

In AMC to CS-E 80, to replace “AMC 20-1” by “AMC 20-1 and AMC 20-3” in four locations.

In AMC to CS-E 170, to replace “AMC 20-1” by “AMC 20-1 and AMC 20-3”.

Proposal 13. To modify the table of contents in CS-E to add the following items at their respective place

CS-E 135 Electrical Bonding

AMC to CS-E 135 Electrical Bonding

AMC to CS-E 1030 Time limited dispatch

- E N D -