Comment Response Document (CRD)
to Notice of Proposed Amendment (NPA) 04-2005

for amending

the Executive Director Decision No. 2006/12/R
on General Acceptable Means of Compliance
for Airworthiness of Products, Parts and Appliances (« AMC-20 »),

the Executive Director Decision No. 2003/11/RM
on Definitions and Abbreviations used in Certification Specifications for products, parts and appliances (« CS-Definitions »),

the Executive Director Decision No. 2003/09/RM
on certification specifications, including airworthiness codes and acceptable means of compliance, for engines (« CS-E »)

Certification of engines equipped with electronic engine control systems

Explanatory Note

I. General

1. The purpose of the Notice of Proposed Amendment (NPA), dated 1 March 2005 was to propose a new AMC 20-3 for the General acceptable means of compliance for airworthiness of products, parts and appliances (AMC-20), and related amendments to CS-Definitions (definitions and abbreviations used in certification specifications for products, parts and appliances) and CS-E (certification specifications for engines).

II. Consultation

2. The draft Executive Director Decision was published on the Agency website (www.easa.europa.eu) on 1 March 2005.

   By the closing date of 2 June 2005, the Agency had received 124 comments from 11 national authorities, professional organisations and private companies.

III. Rulemaking Review Group

3. Due to the nature and extent of the comments received, a rulemaking review group was established as provided for by Article 7 of the EASA Rulemaking procedures[1].

4. The Review Group met just once in September 2005. This CRD is the output from this group and is endorsed by the EASA.

IV. Publication of the CRD

5. All comments received have been acknowledged and incorporated into a Comment Response Document (CRD). This CRD contains a list of all persons and/or organisations that have provided comments and the answers of the Agency.

6. In responding to comments, a standard terminology has been applied to attest EASA's acceptance of the comment. This terminology is as follows:

   - **Accepted** – The comment is agreed by the Agency and any proposed amendment is wholly transferred to the revised text.
   - **Partially Accepted** – Either the comment is only agreed in part by the Agency, or the comment is agreed by the Agency but any proposed amendment is partially transferred to the revised text.
   - **Noted –** The comment is acknowledged by the Agency but no change to the existing text is considered necessary.
   - **Not Accepted** - The comment is not shared by the Agency.

[1] Management Board Decision MB/7/03 from 27 June 2003 concerning the procedure to be applied by the Agency for the issuing of opinions, certification specifications and guidance material ("rulemaking procedure").

7. The Agency's Decision will be issued at least two months after the publication of this CRD to allow for any possible reactions of stakeholders regarding possible misunderstandings of the comments received and answers provided.

8. Such reactions should be received by EASA not later than **15 June 2007** and should be sent by the following link: CRD@easa.europa.eu;

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
1	GE Transportation	AMC 20-3 (8) (a) Scope of the Assessment	Change the sentence that currently reads "Transmission of erroneous parameters which could lead to thrust or power changes greater than 3% .. To 'Transmission of erroneous parameters that could lead to thrust or power changes greater than +/-3% (i.e. 6% peak-to-peak) of rated power or thrust ..'	The proposed wording removes a potential ambiguity and also makes it consistent with the similar statement used in (6)(f)(iii).	**Not Accepted.** The "peak to peak" reference is not relevant when the subject is not oscillation. The text has been improved to refer to take-off thrust or power.	N/A
2	GE Transportation	AMC 20-3 (8) (c) Malfunctions or Faults affecting thrust or power.	1. Change the sentence that currently reads 'In multi-engined aeroplanes, Faults that result in thrust or power changes of less than approximately 10% .. To 'In multi-engined aeroplanes, Faults that result in thrust or power changes of less than approximately +/-10% (i.e. 20% peak-to-peak) of rated power or thrust..' 2. Similarly, change 'The frequency of occurrence of Uncovered Faults that result in a thrust or power change greater than 3% ..'to 'The frequency of occurrence of Uncovered Faults that result in a thrust or power change greater than +/-3% (i.e. 6% peak-to-peak) of rated power or thrust ..' 3. There are two places in the text that are typographical errors. A probability of occurrence is shown as 10-4, but should appear as 10-4 in these two places. 4. There are two places in the text that discuss the sharing of cross-engine thrust or power signals. Both are given as a 3% change. Theses should be expressed as 3% absolute difference of the current	The proposed wording for thrust variation removes a potential ambiguity and also makes it consistent with the similar statement used in (6)(f)(iii).	There are 5 separate comments: 1. **Not Accepted.** The peak to peak reference is not relevant when the subject is not oscillation. 2. **Not Accepted.** The peak to peak reference is not relevant when the subject is not oscillation. 3. **Accepted.** Typographical errors corrected. 4. **Partially Accepted.** Text modified to clarify the first 3% figure. 5. **Not Accepted.** The 10% is related to the Take-off rating.	AMC 20-3 (8) (c) Malfunctions or Faults affecting thrust or power. … The frequency of occurrence … Faults should be reasonably low, in the order of 10^{-4} events per Engine flight hour or less. … Signals sent … The maximum thrust or power loss on the Engine using a cross-Engine signal should generally be limited to 3% absolute difference of the current operating condition. … When operating … A total frequency of occurrence in excess of 10^{-4} events per Engine flight hour would not normally be acceptable.

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			operating condition. 5. Lastly, change the sentence; "which result in a thrust or power change of up to 10% .." to .. "which result in a thrust or power change of 10% absolute difference of current operating condition."			
3	GE Transportation	AMC 20-3 (6) (f) (iv) Maintenance Actions	Propose changing the last paragraph of this section to read as follows: 'The maintenance actions to be considered include scheduled periodic and/or at exposure inspections or tests for required structural shielding, wire shields, connectors, and equipment protection components. The applicant should provide the engineering validation and substantiation of the recommended time interval for periodic inspection or the validation and substantiation for acceptability of at exposure maintenance actions.'	An acceptable maintenance plan may not require periodic or scheduled inspections. Some inspections can be done at opportunities created by other maintenance activities. Those maintenance activities may include removal of the component during engine overhaul, upgrading of engine systems or components, or removal from the engine because of component faults. During these opportunities, components are often returned to a repair facility for inspection, test, and repair. At that time, it may be desirable to include the inspections required for continued airworthiness of the protection devices. The substantiation of a non-periodic maintenance plan shall show that the increased failure rate due to at-exposure as opposed to periodic inspection does not significantly change the	**Partially Accepted**. Intent of the comment has been agreed. The text has been improved.	AMC 20-3 (6)(e) (iv) Maintenance Actions The maintenance actions to be considered include periodic inspections or tests for required structural shielding, wire shields, connectors, and equipment protection components. Inspections or tests when the part is exposed may also be considered. The applicant should provide the engineering validation and substantiation of these maintenance actions.

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				overall failure rate. In this case a change in failure rate of 2% - 5% is not considered significant.		
4	GE Transportation	A. Explanatory Note IV. Discussion of the proposals	In the discussion of the proposed changes, there is a request for comments on the proposal to retain AMC 20-1 when adding AMC 20-3. Retaining AMC 20-1 as currently defined is not desirable. It is recommended that the current paragraphs 4.3 through 4.6 in AMC20-1 be deleted; or if any of that information needs to be retained it be added to the appropriate paragraphs in AMC 20-3. A new 4.3 paragraph could be inserted that points to AMC 20-3 for additional specific guidelines relating to electronic controls.	There is no inconsistency in the guidelines in AMC20-1 and 20-3. However, there is significant overlap in guidelines. It would be less confusing, easier for the user, and easier to make future amendments if the duplication were eliminated.	**Partially Accepted** AMC 20-1 has been modified	(See Annex 2)
5	GE Transportation	AMC 20-3 (7) (c) Uncommanded thrust or power oscillations	Change the sentence that currently reads 'In general, thrust or power oscillations less than 5% of normal maximum rated thrust or power at the flight condition may be considered acceptable' to ' In general, thrust or power oscillations less than +/- 5% (i.e. 10% peak-to-peak) of takeoff thrust or power may be considered acceptable'.	The proposed wording is taken from the recent revision to SAE ARP 5107. The proposed words clarify the numerical limit of acceptable oscillations by adding the more precise peak-to-peak definition. And the proposed words clarify that the limit is a percentage of maximum takeoff thrust or power and not the maximum thrust or power that could be developed at other operating conditions. ARP 5107 goes on to explain that the limit on oscillations is usually associated with	**Partially Accepted** Intent of the comment has been agreed. The text has been improved. It is assumed that Industry has agreed on ARP 5107.	AMC 20-3 (7) (c) Uncommanded thrust or power oscillations Any uncommanded thrust or power oscillations should be of such a magnitude as not to impact aircraft controllability in the intended installation. ~~In general,~~ Thrust or power oscillations less than ~~5% of normal maximum rated thrust at the flight condition may be considered acceptable.~~ 10% peak to peak of Take-off Power and/or Thrust have been considered acceptable in

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				approach and landing phase of the flight and even higher oscillations may be acceptable at other flight conditions. Hence, the +/- 5% of takeoff thrust or power is considered to be a reasonable definition for unacceptable oscillations.		some installations, where the failure affects one engine only. Regardless of the levels discussed herein, if the flight crew has to shut down an Engine because of unacceptable thrust or power oscillations caused by the control system, such an event would be deemed an in-service LOTC/LOPC event.
6	CAA-UK	General	References are made throughout the document to RTCA DO documents and EUROCAE ED documents. In all cases these references should state for example 'EUROCAE ED12 latest issue'	Clarification	**Not Accepted** Document are either referenced by: 1. specific version, where there is potential for future amendments to impact on the interpretation of EASA requirements, or , 2. as an open reference, where EASA has pre-determined that the latest version should always be used.	N/A
7	CAA-UK	A. Explanatory Note IV. Discussion of the proposals	It is suggested that the reference to the 25% thrust loss associated with bird tests is deleted from this section. The reference to the 25% thrust loss in the context of bird tests is misleading here. The 25% figure is derived from the fact that the bird test to which this refers addresses the multiple threats from flocking birds and assumes that all four engines in a 4- engined aircraft are affected. The overall effect should be no worse than the loss of a single	Clarification	**Accepted**	Text does not form part of AMC 20-3

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			engine: hence the 25% maximum allowable loss for any one engine.			
8	CAA-UK	A. Explanatory Note V. RIA (Sectors Affected)	It is suggested that this be changed to read 'The industry sectors affected are the aircraft, engine and propeller type certificate holders and, to a lesser extent, their subcontractors.'	It is incorrect to state that 'There will inevitably be a lesser impact on the propeller and aircraft type certificate holders.' particularly as the use of integrated systems becomes more widespread.	**Accepted.**	Text does not form part of AMC 20-3
9	CAA-UK	CS Definitions	It is suggested that each proposed definition is reviewed in the context of a propeller. (e.g. aircraft-supplied data may equally be used by a propeller control system – it should not be limited to the engine related case)	CS-Definitions is a generic document and the definitions therein should be applicable to all relevant aspects of the other certification specifications	**Accepted.** Terms amended to make them more generic.	**Aircraft-Supplied Data'** ~~(Engine-related definition)~~ means …is used by the Engine/Propeller Control System. **Aircraft-Supplied Electrical Power'** ~~(Engine related definition)~~ means … is used by the Engine/Propeller Control System. **Back-up System'** ~~(Engine related definition)~~ means a part of the Engine/Propeller Control … Engine/Propeller control … impacted or changed. **Primary System'** ~~(Engine related definition)~~ means the part of the Engine/Propeller Control System used for controlling the Engine/Propeller under normal operation.
10	CAA-UK	CS Definitions	Question: With regard to a 'Full-up	There may be a need to	**Not Accepted.**	N/A

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			Configuration', could there be uncovered faults (undetectable) in the EECS?	revise the definition of a 'full-up configuration' if a full-up system can have undetected faults present.	The definition is considered as being adequate. It should be noted that, by principle, an undetected fault is not known.	
11	CAA-UK	AMC 20-3 General comments	(a) There is reference throughout to aircraft, engine and propellers however, there is no reference to Auxiliary Power Units (APUs), the majority of which are now approved for use with electronic control systems. (b) With the introduction of the concept of 'Thrust Control Malfunction (TCM)', it is considered that the publication of this AMC-20 provides a timely opportunity also to introduce guidance on the certification issues associated with TCM. This AMC20 should also provide appropriate advice and guidance on the approval of APUs equipped with electronic controls. In this context too, it is suggested that the title of the document itself be amended to include reference to engines, propellers and APUs.	Self-explanatory. (This may require a new activity and inclusion in the EASA rule-making programme)	**Noted.** (a) For APUs, there is a dedicated AMC 20-2. Any need for change should be subject to a future rulemaking project. **Noted** (b) For TCM, it should be subject to a future rulemaking activity which, among other texts, could adapt AMC 20-1.	N/A
12	CAA-UK	AMC 20-3 (3) Relevant Specifications and Reference Documents	It is suggested that the table (that contains references to various CS-E requirements) in this paragraph be deleted since it is incomplete (for example, it does not refer to CS-E 40 (See CS-E 40 (g))) and would require amendment potentially at each future revision of CS-E.	Self explanatory	**Not Accepted.** The table is considered as being useful. It is not supposed to be exhaustive as stated in the sentence above the table.	N/A
13	CAA-UK	AMC 20-3 (6) (a) (i) Engine	It is suggested that the final sentence in the second sub-para. Be revised to read; 'These	It is considered that the engine operating instructions	**Accepted** Text has been modified	AMC 20-3

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		Test Considerations	modes do not require engine test demonstrations.. . as long as the installation and operating instructions reflect this loss of capability.' .	should reflect any change in the engine's operational capability where this may result in changes that are apparent to the flight crew	accordingly. Clarification is also provided as to what capabilities are referred to. (See also response to Comment 65)	(6)(a)(i) Engine Test Considerations … ~~These above~~ Some capabilities, such as operability, blade-off, rain, hail, bird ingestion etc, may be lost in some control modes that are not dispatchable. These modes do not require engine test demonstration ~~under the adverse conditions for which they have lost capabilities~~ as long as the installation and operating instructions reflect this loss of capability.
14	CAA-UK	AMC 20-3 (6) (a) (ii) Availability	It is not clear why the availability of a back-up system need be routinely checked only for those systems whose use results in no LOTC.	The availability of a back-up system should be established routinely even if there is an associated LOTC. Credit will have been given to the availability of the back-up system, albeit with a LOTC, when establishing the acceptable despatch criteria and limitations for the primary & alternate control modes.	**Partially Accepted** Text has been modified.	AMC 20-3 (6) (a) (ii) Availability ~~If the applicant claims that there is no thrust control/loss of power control (LOTC/LOPC) for a Back-up mode which is not normally exercised, then its a~~Availability of any Back-up Mode should be established by routine testing or monitoring to ensure that ~~it~~ the Back-up Mode will be available when needed. The frequency of establishing ~~the~~ its availability ~~of the back-up Mode~~ should be documented in the instructions for

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						continued airworthiness.
15	CAA-UK	AMC 20-3 (6) (c) Rotorcraft Engines	It is suggested that this text would be better placed in AMC to CS-E 50 in Book 2 of CS-E itself.	Self-explanatory	**Accepted** Text has been modified accordingly.	AMC 20-3 *(6)(c) is deleted and sub-paragraphs renumbered. The proposed text of (6)(c) is added to AMC to CS-E 50*
16	CAA-UK	AMC 20-3 (6) (f) (i) Declared levels	Electromagnetic Effects and Lightning. For HIRF considerations, - the words and environmental levels chosen are not consistent with the FAA / JAA agreed position as recorded at the EEHWG November 1998 meeting. Refer to the standard fixed wing JAA interim policies INT/POL/25/2 and corresponding interim policies for rotorcraft. For Critical systems these interim policies do not allow for laboratory testing and it is suggested that this aspect is deleted.	Consistency	**Not Accepted.** The referenced policies are not related to engine certification. Consistency with aircraft certification is addressed in this AMC 20-3, which suggests to consider the environmental threat levels used for aircraft certification, if available, at the time of engine certification.	N/A
17	CAA-UK	AMC 20-3 (6) (f) (iii) Pass / fail criteria	Remark: A greater than +/- 3% change of rated power (10% for GA) seems to be at variance with previous certifications / validations where figures of 1% or 2% have been used. 10% for GA seems high!	Clarification sought.	**Partially Accepted** The explanatory note of this NPA explains the 3% figure. The 10% for general aviation has been eliminated. (See also comment 42 and 61)	AMC 20-3 (6) ~~(f~~ e) … (iii) Pass/Fail Criteria ... The following are considered adverse effects: - A greater than ~~+/-~~ 3% ~~(+/- 10% for general aviation installations)~~ change of ~~rated~~ Take-off Power or Thrust ~~from the normal control governing capability~~ for a period of

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						more than ~~one~~ two seconds. …
18	CAA-UK	AMC 20-3 (7) (g) Single Fault Accommodation	It is suggested that the third sub-paragraph be deleted since this states that the failure of a single component, when this results in a LOTC/LOPC, may be acceptable. This is highly undesirable and should not be encouraged.	The increasing complexity of EECS means that it is also becoming very difficult fully to establish and test all of the potential failure modes and effects. To allow a single fault to result in a LOTC/LOPC implies a level of confidence in the coverage of analyses and tests that is not justified.	**Not Accepted** The whole paragraph is intended to explain the rule on "essentially single fault tolerant".	N/A
19	CAA-UK	AMC 20-3 (7) (h) Local Events	It is suggested that the 4th sub-para. Of the 8th paragraph of (h) be amended to read: 'The applicant should assess by analysis or test the effects of hydraulic, fuel and lubricating fluid leaks impinging on components of the ..etc.. Etc.'	Fuel leaks may also affect the EECS.	**Partially Accepted** Intent of the comment has been agreed. The text has been improved.	AMC 20-3 (7) (h) Local Events … The applicant should assess by analysis or test the effects of ~~hydraulic or lubricating~~ fluid leaks impinging on components of the Electronic Engine Control System. …
20	CAA-UK	AMC 20-3 (8) (b) (iv) The Consequence of the transmission of a faulty parameter	It is suggested that the second sub-para. be deleted entirely.	This text is relevant not only to engines with EECS but to all engines. It would therefore be better placed in AMC applicable to all engines.	**Not Accepted.** The text is kept in AMC 20-3 for the purpose of illustrating the concept.	N/A
21	CAA-UK	AMC 20-3 (10) (d) On-board or Field Software	The subject covered here is a post-TC activity and may be more appropriately presented in AMC to Part 21 for example.	It is recommended that consideration be given to the need for this information in	**Noted** The need for future rulemaking activity on this	N/A

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		Loading and Part Number Marking		this particular AMC.	general subject shall be reviewed by the agency.	
22	CAA-UK	IV. Discussion of Proposals	Retention of AMC 20-1 is supported. It contains information that is pertinent to the airframer's responsibility that is not entirely included in the proposed AMC 20-3. However in the longer term AMC 20-1 should be reviewed to rationalise the information in this section with that of AMC 20-3.	Completeness of Advisory Material.	**Partially Accepted** AMC 20-1 has been adapted.	(See amended AMC 20-1)
23	Turbomeca	AMC 20-3 (7) (h) Local Events	It is proposed to modify the 1st subparagraph of paragraph (7)(h) as follows: " (h) Local Events Examples of local events to be considered under CS-E 50 (c)(4) include: - Overheat conditions, for example, those resulting from hot air duct bursts, - Fires, and - Fluid leaks or mechanical disruptions which could lead to damage to control system electrical harnesses, connectors, or the control unit(s). These local events would normally be limited to one Engine. Therefore, a local event is not usually considered to be a common mode event, and common mode threats, such as HIRF, lightning and rain, are not considered local events. ~~Whatever the local event, the behaviour of the EECS should not cause a Hazardous Engine Effect in any dispatchable mode.~~ "	This is not the purpose of AMC 20-3 to define additional specifications for dispatchable configurations. Relevant specifications for EECS dispatchable configurations are defined in CS-E 1030 and acceptable means of compliance are defined in AMC to CS-E 1030. This seems to be a "rule" by "AMC". See also comment made on the 4th subparagraph of (6)(a).	**Accepted** Text has been modified accordingly.	AMC 20-3 (7) (h) Local Events … ~~Whatever the local event, the behaviour of the EECS should not cause a Hazardous Engine Effect in any dispatchable mode.~~ ....

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24	Turbomeca	AMC 20-3 (2) SCOPE	If AMC 20-1 is retained, It is proposed to modify AMC 20-3 paragraph (2) in the 4th subparagraph ,last sentence as follows: "This guidance relates to issues to be considered during engine certification. AMC 20-1 **paragraph 6** complements this document on issues associated with the engine installation in the aircraft."	This is to clarify which paragraph of AMC 20-1 complements AMC 20-3 for engine certification. This is consistent with the cross reference made to AMC 20-1 in paragraph 15(c)iii of AMC 20-3.(see also comment related to Part A-IV.)	**Partially Accepted.** Intent of the comment is agreed. The text has been improved	AMC 20-3 (2) SCOPE … This document also discusses the division of compliance tasks for certification between the applicants for Engine, Propeller (when applicable) and aircraft type certificates. This guidance relates to issues to be considered during engine certification. AMC 20-1 ~~complements this document on~~ addresses issues associated with the engine installation in the aircraft. …
25	Turbomeca	AMC 20-3 (2) SCOPE 5th subparagraph	It is proposed to add reference to CS-E 80 for electromagnetic disturbance as follows: " Insufficient protection from electromagnetic disturbance (lightning, internal or external radiation effects) [see CS-E 50(a)(1), **CS-E 80** and CS-E 170],"	To complement the cross-references and to be consistent with paragraph (6)(f) of AMC 20-3.	**Accepted** Text has been modified accordingly.	AMC 20-3 (2) SCOPE … - Insufficient protection from electromagnetic disturbance (lightning, internal or external radiation effects) [see CS-E 50 (a)(1), CS E-80 and CS-E 170], ….
26	Turbomeca	AMC 20-3 (3) RELEVANT	It is proposed to add reference to E 250 'fuel system' in the table.	CS-E 560 is in reference in the table for fuel system of	**Accepted** Text has been modified	Reference to "CS-E 250 (Fuel System)" added.

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		SPECIFICATIONS AND REFERENCE DOCUMENTS		turbine engines. For consistency, CS-E 250 fuel system for piston engines should also included in the table.	accordingly.	
27	Turbomeca	AMC 20-3 (4) DEFINITIONS	It is proposed to add a new sentence as follows: " (4) DEFINITIONS The words defined in CS-Definitions and in CS-E 15 are identified by capital letter. **Where dispatch with faults are addressed within this AMC, this is always related to dispatch of faults as covered by CS-E 1030.** The following figure and associated definitions are provided to facilitate a clear understanding of the terms used in this AMC."	This is to clarify that dispatch with faults when addressed in this AMC only refers to dispatch of faults as considered by CS-E 1030. As CS-E 1030 does not cover all dispatchable faults but only loss of redundancy in EECS, this needs to be clarified. It is understood that it has not been the intent of the drafting group to address more "dispatchable faults" in AMC20-3 than those covered in CS-E 1030.	**Not Accepted** Although the comment is understood, the proposed change is not appropriate to paragraph (4) which deals with definitions. Further references to CS-E 1030 are added to clarify dispatchable configurations.	
28	Turbomeca	AMC 20-3 (6) (a) Control Modes - General	It is proposed to delete the 2nd subparagraph of (6)(a) as follows: " Under CS-E 50 (a) the applicant should perform all necessary testing and analysis to ensure that all Control Modes, including those which occur as a result of control Fault Accommodation strategies, are implemented as required. ~~All dispatchable Control Modes should be capable of performing their intended functions in the environmental conditions, including High Intensity Radiated Fields (HIRF) and lightning, declared in the Engine instructions for installation~~. The need to provide protective functions, such as over-speed protection, for all	This is redundant with CS-E 1030(b)(6). Therefore this 2nd subparagraph is not useful. In addition, dispatchable configurations are not addressed by CS-E 50 but by CS-E 1030. Therefore it is proposed to delete this 2nd subparagraph.	**Accepted** Text has been modified accordingly.	AMC 20-3 (6) (a) Control Modes - General …. ~~All dispatchable Control Modes should be capable of performing their intended functions in the environmental conditions, including High Intensity Radiated Fields (HIRF) and lightning, declared in the Engine instructions for installation~~. ….

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			Control Modes, including any Alternate Modes, should be reviewed under the specifications of CS-E 50 (c), (d) and (e), and CS-E 210 or CS-E 510."			
29	Turbomeca	AMC 20-3 (6) a) Control Modes - General	It is proposed to delete the 4th subparagraph of (6)(a) as follows: "~~CS-E 50 (c) applies to the Engine Control System operating in any dispatchable configuration.~~"	The purpose of CS-E 50 is not to address dispatchable configurations. Specifications for EECS dispatchable configurations are defined in CS-E 1030 and its dedicated AMC. This sentence is therefore very confusing even in contradiction with CS-E 1030. This is not the purpose of AMC 20-3 to define additional specifications for dispatchable configurations. (CS-E 50(c)(1) is for full up configuration; indeed AMC to CS-E 1030 defines other criteria for dispatchable configurations. CS-E 50(c)(2) is for full up configuration by definition. CS-E 50(c)(3) is replaced by CS-E 1030(b)(5) for dispatchable configurations. CS-E 50(c)(4) does not seem to be applicable to dispatchable configurations according to CS-E 1030). See also comment made against the 1st subparagraph of paragraph (7)(h).	**Accepted** Text has been modified accordingly.	AMC 20-3 (6) (a) Control Modes - General …. ~~CS-E 50 (c) applies to the Engine Control System operating in any dispatchable configuration.~~ ….

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30	Turbomeca	AMC 20-3 (6) (a) (i) Engine Test Considerations	It is proposed to modify paragraph (6)(a)(i) as follows: " (i) Engine Test Considerations If the Engine certification tests … that the Engine can meet the defined test-success criteria when operating in any Alternate mode that is proposed as a dispatchable configuration **as required by CS-E 1030**. ~~This would be applicable to test requirements that demonstrate capabilities such as operability, blade off, rain, hail, bird ingestion etc.~~ These above capabilities …reflect this loss of capability."	This subject is the purpose of CS-E 1030 and AMC to CS-E 1030 and covered by them. In addition, this sentence is in contradiction with CS-E 1030. Blade off is not in CS-E 1030. Therefore it is proposed to delete this sentence and to refer to CS-E 1030.	**Accepted** Text has been modified accordingly.	AMC 20-3 (6) (a) (i) Engine Test Considerations If the Engine certification tests …test-success criteria when operating in any Alternate mode that is proposed as a dispatchable configuration **as required by CS-E 1030**. ~~This would be applicable to test requirements that demonstrate capabilities such as operability, blade off, rain, hail, bird ingestion etc.~~ ....
31	Turbomeca	AMC 20-3 (6) (f) (v) Time Limited Dispatch (TLD) Environmental Tests.	It is proposed to modify paragraph (6)(f)(v) as follows: "(v) Time Limited Dispatch (TLD) Environmental Tests Although TLD is only an optional requirement for certification (see CS-E 1000 and CS-E 1030), HIRF and lightning tests for TLD are usually conducted together with tests conducted for certification. **Acceptable means of compliance are provided in paragraph (5) of AMC to CS-E 1030.** ~~In order to gain approval for the use of TLD, applicants should demonstrate that dispatchable Engine Control System configurations continue to meet all relevant specifications, including environmental specifications, of the certification basis. For~~	This subject is the purpose of CS-E 1030 and AMC to CS-E 1030 and covered by them. Relevant specification is defined in CS-E 1030 (b)(6) and acceptable means of compliance are provided by AMC to CS-E 1030. In addition, there is a risk of contradiction in case of update of CS-E 1030 and its AMC. Therefore it is proposed to refer to AMC to CS-E 1030 for acceptable means of compliance.	**Accepted** Text has been modified accordingly.	AMC 20-3 (6) (~~f~~e) (v) Time Limited Dispatch (TLD) Environmental Tests Although TLD is only an optional requirement for certification (see CS-E 1000 and CS-E 1030), EMI, HIRF and lightning tests for TLD are usually conducted together with tests conducted for certification. Acceptable means of compliance are provided in AMC to CS-E 1030. ~~In order to gain approval for the use of TLD, applicants should demonstrate that dispatchable Engine Control~~

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
			~~example, in some cases a single channel dispatch configuration is the worst case dispatch configuration and HIRF and lightning tests should be conducted on such a configuration to demonstrate compliance.~~ "			~~System configurations continue to meet all relevant specifications, including environmental specifications, of the certification basis. For example, in some cases a single channel dispatch configuration is the worst case dispatch configuration and HIRF and lightning tests should be conducted on such a configuration to demonstrate compliance.~~
32	Turbomeca	AMC 20-3 (7) (g) Single Fault Accommodation	It is proposed to modify 1st subparagraph of paragraph (7)(g) as follows: "(g) Single Fault Accommodation Compliance with the single Fault specifications of CS-E 50 (c)(2) and (3) may be substantiated by a combination of tests and analyses. The intent is that single Failures or malfunctions in the Engine Control System's components, in its fully operational condition ~~and all dispatchable configurations~~, do not result in a Hazardous Engine Effect. In addition, in its full-up configuration the control system should be essentially single Fault tolerant of electrical/electronic component Failures with respect to LOTC/LOPC events. **For dispatchable configurations refer to CS-E 1030 and AMC to CS-E 1030**".	This subject is the purpose of CS-E 1030 and AMC to CS-E 1030 and covered by them. Relevant specification for dispatchable configuration is defined in CS-E 1030 (b)(5) and acceptable means of compliance are provided by AMC to CS-E 1030. There is no added value to try to repeat here (in a less clear manner) what is defined in CS-E 1030 but this could lead to potential confusion. In addition, there is a risk of contradiction in case of update of CS-E 1030 and its AMC. Therefore it is proposed to refer to CS-E 1030 and to AMC to CS-E 1030 for acceptable means of compliance.	**Accepted** Text has been modified accordingly.	AMC 20-3 (7) (g) Single Fault Accommodation Compliance with the single Fault specifications of CS-E 50 (c)(2) and (3) may be substantiated by a combination of tests and analyses. The intent is that single Failures or malfunctions in the Engine Control System's components, in its fully operational condition ~~and all dispatchable configurations~~, do not result in a Hazardous Engine Effect. In addition, in its full-up configuration the control system should be essentially single Fault tolerant of electrical/electronic

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
						component Failures with respect to LOTC/LOPC events. For dispatchable configurations refer to CS-E 1030 and AMC to CS-E 1030".
33	Turbomeca	IV. Discussion of the proposals	The explanatory note specifically requests comments on the proposal to retain AMC 20-1. (1) Retaining AMC 20-1 results in "duplication" of several paragraphs. However this is not a true duplication: the "duplicated" paragraphs are not identical and do not use the same wording. For example AMC 20-1 paragraph 4.4.2.b says " must not cause a hazard to the aircraft" whereas CS-E 50(c)(4) and AMC 20-3 para 7(h) say" not result in a Hazardous Engine Effect". Similar difference exists with paragraphs dealing with aircraft electrical power supply. Other differences exist in other paragraphs. This could lead to confusion: which AMC is to be used for Engine certification? This should be clarified. AMC 20-3, which is normally the one to be used for an engine certification, only refers to AMC 20-1 in a general manner in paragraph 2-"Scope" and specifically for distribution of tasks in paragraph 15(c)iii " ENGINE, PROPELLER AND AIRCRAFT SYSTEMS INTEGRATION AND INTER-RELATION BETWEEN ENGINE, PROPELLER AND AIRCRAFT CERTIFICATION ACTIVITIES - Certification activities - Distribution of	(1) as explained above. This will clarify that for engine certification AMC 20-3 is to be used complemented by para 6 of AMC 20-1 and will prevent conflict during engine certification process due to different wording of similar paragraphs in the 2 AMCs. (2) Self-explanatory. (3) Self-explanatory.	There are 3 separate comments: 1. **Partially Accepted** A reference to Paragraph 6 is considered unnecessary. Scope of AMC 20-3 has already been clarified (See Comment 24) 2. **Not Accepted** The 2 documents are considered consistent. 3. **Partially Accepted** AMC 20-1 has been modified accordingly.	(See amended AMC 20-1)

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
			Compliance Tasks". Therefore, if AMC 20-1 is finally retained, it will be proposed to modify AMC 20-3 paragraph (2), 4th subparagraph as follows: "This guidance relates to issues to be considered during engine certification. AMC 20-1 **paragraph 6** complements this document on issues associated with the engine installation in the aircraft." (2) AMC 20-1 refers only to turbine engines (in para 2.1 only paragraphs related to turbine engines are in reference) whereas AMC 20-3 covers all engines: is it consistent? (3) AMC 20-1 paragraph 2.1 refers to CS-E sections A, D, E instead of Subparts A, D, E and specify E130 as being in section D instead of subpart A.			
34	Turbomeca	AMC 20-3 (7) (h) Local Events	In page 27 it is proposed to replace " non - hazardous effects" by non- Hazardous Engine Effects" as follows: " The following guidance applies to Engine Control System wiring: - Each wire or combination of wires interfacing with the EECS that could be affected by a local event should be tested or analysed with respect to local events. The assessment should include opens, shorts to ground and shorts to power (when appropriate) and the results should show that Faults result in identified responses and do not result in Hazardous Engine Effects.	For consistency within all this AMC and with CS-E.	**Accepted.** Text has been modified.	AMC 20-3 (7) (h) Local Events The following guidance applies to Engine Control System wiring: - Each wire … - Engine control unit aircraft interface wiring should be tested or analysed for shorts to aircraft power, and these 'hot' shorts should result in an identified and non-~~hazardous effect~~ Hazardous Engine Effect. ~~, as well.~~

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
			- Engine control unit aircraft interface wiring should be tested or analysed for shorts to aircraft power, and these 'hot' shorts should result in an identified and non- **Hazardous Engine Effect** , as well..."			Where aircraft interface …
35	Turbomeca	AMC 20-3 (8) (c) Malfunctions or faults affecting thrust or power	(Comment withdrawn by commenter)			N/A
36	Turbomeca	AMC 20-3 (9) (a) Rotor Over-speed protection	It is proposed to modify the 3rd subparagraph of paragraph (9)(a) as follows: " (9) PROTECTIVE FUNCTIONS (a) Rotor Over-speed Protection. Compliance with CS-E 50 (e) is usually achieved by providing an independent over-speed protection system, such that it requires two independent Faults or malfunctions (as described below) to result in an uncontrolled over-speed. The following guidance applies if the rotor over-speed protection is provided by an Engine Control System protective function. ~~In all dispatchable configurations, the combined Engine and over-speed protection system should be at least two independent Faults removed from an uncontrolled over-speed event. Hence, a potential rotor burst due to over-speed should only be possible as a result of a first Fault causing an over-speed and an independent second Fault preventing the over-speed protection sub-system from operating properly.~~ **For dispatchable configurations, refer to**	Dispatch configuration is the purpose of CS-E 1030 and AMC to CS-E 1030 and covered by them. Appropriate specification for dispatchable configuration is defined in CS-E 1030 (b)(3) and (5) and acceptable means of compliance are provided by AMC to CS-E 1030. There is no added value to have redundant text here but this could lead to potential confusion. In addition, there is a risk of contradiction in case of update of CS-E 1030 and its AMC. Therefore it is proposed to refer to CS-E 1030 and its AMC for dispatchable configurations.	**Accepted** Text has been modified accordingly.	AMC 20-3 (9) (a) Rotor Over-speed Protection. ~~Compliance with CS-E 50 (e)~~ Rotor over-speed protection. is usually achieved by providing …Control System protective function. ~~In all dispatchable configurations, the combined Engine and over-speed protection system should be at least two independent Faults removed from an uncontrolled over-speed event. Hence, a potential rotor burst due to over-speed should only be possible as a result of a first Fault causing an over-speed and an independent second Fault preventing the over-speed protection sub-system from operating properly.~~ For dispatchable

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
			CS-E 1030 and AMC to CS-E 1030."			configurations, refer to CS-E 1030 and AMC to CS-E 1030."
37	Turbomeca	AMC 20-3 (10) (c) Level of software design assurance	It is proposed to replace "reciprocating" by "piston" in the 2nd subparagraph of paragraph (10)(c).	To be consistent with CS-E.	**Accepted** Text has been modified accordingly.	AMC 20-3 (10) (c) Level of software design assurance … The criticality of functions on other aircraft may be different, and therefore, a different level of software design assurance may be acceptable. For example in the case of a ~~reciprocating~~ piston engine in a single-engined aircraft, …
38	Turbomeca	AMC 20-3 (10) (d) On-board or field software loading and part numbering	It is proposed to modify the 3rd and 4th subparagraphs of paragraph (10)(d) as follows: " (d) On-Board or Field Software Loading and Part Number Marking The following guidelines ... For those ~~EECS~~ **electronic engine control system units** having separate part numbers for hardware and software, … For those Electronic Engine Control System **units** having only one part number, … returned to service." …	It is assumed this is the equipment unit, which has part numbers not the system as said later in the sentences.	**Partially Accepted** Intent of the comment has been agreed. The text has been improved.	AMC 20-3 (10) (d) On-Board or Field Software Loading and Part Number Marking The following guidelines … For ~~those~~ an EECS unit having separate part numbers for … the software part number(s) is(are) embedded in the loaded software and … For ~~those Electronic Engine Control Systems~~ an EECS

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
						unit having only … The configuration control system for ~~Electronic Engine Control Systems~~ an EECS that will be … …
39	Turbomeca	AMC 20-3 (12) (a) Objective	It is proposed to write "Hazardous Engine Effects" in place of "hazardous Engine effects".	To be compliant with CS-E 15(c).	**Accepted** Text has been modified accordingly.	AMC 20-3 (12) (a) Objective As required by CS-E 50 (g), ..,without unacceptable effects on thrust or power, ~~hazardous~~ Hazardous Engine ~~effects~~ Effects, or loss of ability to comply with the operating specifications of CS-E 390, CS-E 500 (a) and CS-E 745, as appropriate. (b)…
40	Turbomeca	AMC 20-3 (12) (e) Validation	It is proposed: 1) to modify the 2nd subparagraph of (12)(e) as follows: "(e) Validation Functionality of the … For all dispatchable Control Modes, the next single Fault **in the EECS** should be shown not to lead to a Hazardous Engine Effect." 2) Or to delete this 2nd subparagraph and to	1) to be compliant with CS-E 1030. 2) To avoid unnecessary redundancy and future potential risk of conflict with CS-E 1030.	**Accepted** Second proposal is adopted.	AMC 20-3 (12) (e) Validation … For all dispatchable Control Modes, ~~the next single Fault should be shown not to lead to a Hazardous Engine Effect~~ see CS-E 1030 and AMC to CS-E 1030. If an Alternate Mode, …

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
			add a reference to CS-E 1030 and its AMC for dispatchable configurations.			
41	Turbomeca	AMC 20-3 (13) (b) Analysis of the design architecture	It is proposed to modify the 4th subparagraph as follows: "When compliance with CS-E 50 (h)(1) imposes a dedicated electrical power source, Failure of this source should be addressed in the LOTC/LOPC analysis required under CS-E 50 (c). ~~While no credit is normally given in the LOTC/LOPC analysis for the use of aircraft supplied electrical power as a back-up power source~~, ~~a~~**A**ircraft power has typically been provided for the purpose of accommodating the loss of the Engine's dedicated power supply. ~~However,~~ LOTC/LOPC allowance and any impact on the SSA for the use of aircraft power as the power source for an Engine control Back-up System would be **addressed.** ~~reviewed. On a case-by-case basis.~~"	The removed sentence seems to be in contradiction with CS-E 50(h)(1) which says:" The effect of the loss or interruption of aircraft supplied electrical power must be taken into account in complying with CS-E 50(c)(1)" (CS-E 50(c)(1) dealing with rate of LOPC). The removed sentence (by requiring to be double fault tolerant for LOPC) is also in contradiction with CS-E 50 (c)(2) which require to be single fault tolerant for electrical failures with respect to LOPC events. The removed sentence does not reflect the normal usage: Aircraft supplied electrical power is used as a backup to engine dedicated power source and credit for it is usually given in the LOPC analysis.	**Partially Accepted** The intent is to review each case on an individual basis: credit in the LOTC/LOPC analysis is not "usually" given as stated by the commenter.	(Refer to Annex 1)
42	Boeing	AMC 20-3 (6) (f) (iii) "Pass/Fail Criteria"	The proposed text states: 'The following are considered adverse effects: - A greater than +/- 3 % (+/- 10% for general aviation installations) change	1) Previous to this proposed rule, systems have been certificated using a 2 second time limit for recovery to normal operation. For large aircraft this has been satisfactory. One second, as	**Partially Accepted** (See also response to Comments 17 and 61)	AMC 20-3 (6) ~~(f~~ e) … (iii)Pass/Fail Criteria

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
			of rated power or thrust from the normal control governing capability for a period of more than one second. … -Significant Fault codes recorded in the Fault memory. … 1) Revise the adverse affect stated as "*A greater than +/- 3% change .. for a period of more than one second*" to read: "*A greater than +/- 3% change .. for a period of more than **two** seconds*." 2) Delete the adverse affect stated as "*Significant Fault codes recorded in fault memory*."	proposed, is unnecessarily restrictive. The proposal does not specify that this revised figure is based on new data and no additional safety benefit is indicated. 2) Storage of fault codes by itself does not affect continued safe flight and landing. Fault codes that would cause the crew to take inappropriate and unnecessary actions are prohibited by the following adverse effect definition listed in the proposal ("False annunciation to the crew which would cause unnecessary or inappropriate crew action").		... The following are considered adverse effects: - A greater than ~~+/-~~ 3% ~~(+/- 10% for general aviation installations)~~ change of ~~rated~~ Take-off Power or Thrust ~~from the normal control governing capability~~ for a period of more than ~~one~~ two seconds. … ~~- Significant Fault codes recorded in fault memory~~ …
43	Snecma	AMC 20-3 (6) (a) (ii) Availability	Proposal is to modify slightly the paragraph with text in bold : If the applicant claims that there is no thrust control/loss of power control (LOTC/LOPC) **thanks to** ~~for~~ a Back-up Mode which is not normally exercised, then its availability should be established by routine testing or monitoring to ensure that it will be available when needed. The frequency of establishing the availability of the Back-up Mode should be documented in the instructions for continued airworthiness.	The requirement to test the back-up mode for availability won't help to prove that there is no LOTC/LOPC in this back-up mode. It will just prove that the mode is available. To prove that the back-up Mode doesn't lead to LOTC/LOPC, a LOTC/LOPC analysis would be normally required, according to (7)(e). But it doesn't seem to be the intent of the paragraph.	**Partially Accepted** (See Comment 14)	N/A

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
44	Snecma	AMC 20-3 (7) (d) (i) For turbine engines	Proposal is to add the case of LOPC in the sentence : The Electronic Engine Control System should not cause more than one LOTC/**LOPC** event per 100 000 engine flight hours.	'Turbine engines' includes applications were the output is power; in this case there may be LOPC but not LOTC.	**Accepted** Text has been modified accordingly. (See also Comment 62(#6))	AMC 20-3 (7) (d) … (i) For turbine Engines The ~~Electronic Engine Control System~~ EECS should not cause more than one LOTC/LOPC event per 100 000 engine flight hours. (ii)…
45	Snecma	AMC 20-3 (13) (b) Analysis of the design architecture Para. 2	Proposal is to add in the Para. 2 the text in bold <<SEE PAPER COPY>>: The capacity of any Engine dedicated power source which would be required for complying with CS-E 50 (h)(1) should provide sufficient margin to maintain confidence that the Engine Control System will continue to function in all anticipated Engine operating conditions where the control system is designed and expected to recover Engine operation **automatically** in-flight. **Typically, the autonomy of the Engine Control System should be sufficient to ensure its functioning in the case of immediate automatic relight after unintended shutdown. Conversely, the autonomy of the Engine Control System in the whole envelope of Restart in windmilling conditions is not expected to be covered here but may be required by the airframer**....	The present Para. 2 of the AMC (13)(b) is apparently addressing the same subject as rule CS-E 50(h)(2). But it is not giving much additional information compared to the rule. In particular, it is not clear which Engine operating conditions are intended to be covered. As the conditions in the rule pertain to automatic recovery of Engine operation below idle, it can be assumed that the intent is to cover typically relight and restart. The extent of relight or restart to cover is not indicated , so it is proposed to clarify this point.	**Partially Accepted** Intent of the comment has been agreed. The text has been improved.	(Refer to Annex 1)
46	SMA	AMC 20-3 (8) (c) Malfunctions	When operating in the take-off envelope, detected Faults in the Engine Control	It seems like the 10% figure used in (8) (c) is consistent	**Accepted.** Text has been modified	AMC 20-3 (8)

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		or faults affecting thrust or power. 7th§.	System, which result in a thrust or power change of up to 10% (15% for pistons engines), may be acceptable if the total frequency of occurrence for these types of Failures is relatively low.	with 90% figures used to define a LOTC/LOPC in paragraph (7) (b) (i), (ii), and (iii) but not with the 85% figure used in the definition of LOPC (7) (b) (iv) for pistons engines.	accordingly.	… (c) Malfunctions or faults affecting thrust or power. … When operating in the take-off envelope, detected Faults in the Engine Control System, which result in a thrust or power change of up to 10% (15% for piston engines) may be acceptable …
47	SMA	AMC 20-3 (8)(a) and (c).	(8)(a) Instead of : […..Transmission of erroneous parameters which could lead to thrust or power changes greater than 3% (e.g., false high indication of the thrust or power setting parameter) or to Engine shutdown (e.g., high EGT or turbine temperatures or low oil pressure).[..] it is proposed the following: [..Transmission of erroneous parameters which could lead to thrust or power changes greater than 3% (10% for general aviation installations) (e.g., false high indication of the thrust or power setting parameter) or to Engine shutdown (e.g., high EGT or turbine temperatures or low oil pressure).[..] (8)(c) Instead of :	Discussion of the proposed AMC 20-3 states that 'The +/- 3% figure for turbine engines, which appears in paragraphs 6 (f)(iii) (8)(a) and (c), is used consistently in the engine airworthiness code. This can be found, for example, as a criterion in the AMC to CS-E 790 on rain and hail tests (paragraph (5)(c)(vi)(A)). [..] The 10% value for general aviation aircraft, which also appears in paragraph 6 (f)(iii), comes from prior coordination between some authorities and manufacturers.' Therefore, it is requested to define a 10% figure for general aviation aircraft in paragraphs, (8)(a) and (c) to	**Partially Accepted** A figure of 10% has been agreed for piston engines. It is noted that "general aviation" aircraft can be fitted with turbine engines as well as piston engines. There is no justification for differentiating among all turbine engines and therefore no justification for a special treatment of "general aviation".	AMC 20-3 (8)(a) Scope of the assessment … - Transmission of erroneous parameters which could lead to thrust or power changes greater than 3% of Take-off Power and/or Thrust (10% for piston engines installations) (e.g., false high indication of the thrust or power setting parameter) or to Engine shutdown (e.g., high EGT or turbine temperatures or low oil pressure). … AMC 20-3

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			[…]When operating in the take-off envelope, Uncovered Faults in the Engine Control System which result in a thrust or power change of less than 3% are generally considered acceptable. [..] it is proposed the following: [..]When operating in the take-off envelope, Uncovered Faults in the Engine Control System which result in a thrust or power change of less than 3% (10% for general aviation installations) are generally considered acceptable. [..]	be consistent too.		(8)(c) Malfunctions or Faults affecting thrust or power … When operating in the take-off envelope, Uncovered Faults in the Engine Control System which result in a thrust or power change of less than 3% (10% for piston engines installations), are generally considered acceptable. However, …
48	Pratt&Whitney	AMC 20-3 (10) (d) On-Board or Field Software Loading and Part Number Marking	Replace "The loading system should be in compliance with the guidelines of DO-178B." with "The loading system should be in compliance with the guidelines of DO-178B. **Loading systems utilizing CRC checks shall be sufficient to determine successful software loads and do not require tool qualifications**."	It has been found acceptable that loaders with CRC checks meet the appropriate reliability requirements intended by DO-178B Level A qualification.	**Not Accepted** The counter proposal is not a true statement : it depends upon the level of CRC checks.	N/A
49	Pratt&Whitney	AMC 20-3 (6) (a) (ii) Availability	Add 'loss of' between the words 'no' and 'thrust'.	Should be consistent with acronyms in parenthesis.	**Partially Accepted** Intent of the comment is agreed. Text is amended in response to other comments. (See comment 14)	N/A
50	Pratt&Whitney	AMC 20-3 (7) (b) Definition of an LOTC/LOPC event	1. Change '..CS-E 500..' to ..CS-E 500(a)..' 2. Rewrite reference to CS-E 745 to account for conflict in thrust range identified in bullet 1 of this paragraph and the thrust ranges specified in CS-E 745.	1. CS-E 500 items b & c are not relevant to operability related to LOTC. 2. CS-E 745 specifies thrust ranges for operability that are not consistent with the	**1. Accepted** Text has been modified accordingly. **2. Not Accepted** CS-E 745 addresses a totally different subject.	AMC 20-3 (7) … (b) Definition of an LOTC/LOPC event

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				range specified. To meet the requirements CS-E 745 the engine requires a thrust range of idle to 95% of rated takeoff thrust. This would supercede the requirements as specified in bullet one which allows a range of idle to 90% of maximum rated thrust.		… - has lost the capability to govern the Engine in a manner which allows compliance with the operability specifications given in CS-E 500 (a) and CS-E 745.
51	Pratt&Whitney	AMC 20-3 (7) (e) LOTC/LOPC Analysis	Further definition is required for components that should be included in the LOTC/LOPC analysis. The SAE-36 Electronic Engine Control Committee is currently working on an update to ARP5107A that will provide more detailed guidance on components to be included in the LOTC analysis and how to handle field events associated with periodic TLD reporting data.	Specifying components to be included will ensure that all applicants are performing the analysis in a consistent and repeatable manner.	**Not Accepted** This activity on SAE ARP document is noted.	N/A
52	Pratt&Whitney	AMC 20-3 (8) (a) Scope of the Assessment	Paragraph should read as follows: '.. such as: - Transmission of erroneous parameters which could lead to thrust or power changes greater than **10**% (e.g., false high indication of the thrust or power setting parameter) or to engine shutdown (e.g., high EGT or turbine temperatures or low oil pressure). The following should be considered and documented to the airframer for inclusion in the airframe SSA: - Failures which result in the Engine's inability to meet the operability	The intent of the change is to separate those items required as part of CS-E engine certification and those items required to support aircraft certification. Engine certification may precede aircraft certification by a significant time frame. During this time, changes to airframe certification documentation may occur which will require updating of engine certification documentation. While it is recognized that the indicated data is the result of the	**Not Accepted** The paragraph already deals with embodying these items in the Engine's Instructions for installation.	N/A

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			specifications. If these Failure cases are not considered as LOTC/LOPC events, the expected frequency of occurrence for these events should be documented. - Transmission of erroneous parameters which could lead to thrust or power changes greater than 3% (e.g., false high indication of the thrust or power setting parameter) or to Engine shutdown (e.g., high EGT or turbine temperatures or low oil pressure). - Failures affecting functions included in the Engine Control System, which may be considered aircraft functions (e.g. propeller control, thrust reverser control, control of cooling air, control of fuel recirculation).	engine SSA process, documentation of the analysis results should be transmitted outside the engine certification documentation. Having this data as part of the engine SSA documentation and aircraft SSA documentation may lead to discrepancies between the submitted analyses due to time frame differences.		
53	Pratt&Whitney	AMC 20-3 (9) (b) Other protective functions	6th paragraph, Second sentence should read as follows: 'Functions which are added to support aircraft certification **should be considered and documented to the airframer for inclusion in the airframe SSA**, so that the information of those failure modes will get properly assessed and passed on to the installer.'	This change provides consistency with recommended changes to paragraph (8) System Safety Assessment (a) Scope of the Assessment, 5th paragraph.	**Partially Accepted.** Intent of the comment has been agreed. The text has been improved.	AMC 20-3 (9) … (b) Other protective functions … The overall requirement is … the system. This includes those functions which are added to support aircraft certification, so that the information of those Failure modes will get properly ~~assessed~~ addressed and passed on to the installer for inclusion in the airframe SSA. Information concerning the frequencies of occurrence of those Failure modes may

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						be needed as well.
54	Pratt&Whitney	AMC 20-3 6) (f) (ii) (A) General	Replace 'FAA AC 20-136' with 'SAE ARP 5412, 5413, 5414, and 5416'	(A) FAA AC20-136 is outdated and in many cases (Environmental definitions) incorrect. The SAE ARP's cited were a joint effort of EUROCAE ED14/WG31 and the SAE AE2 Lightning Committees. (B) These changes are consistent with those proposed by JAA in 2003 in draft Policy Paper TGM/27&29/XX, which would have replaced Policy Paper INT/POL/25/4, Issue 3.	**Accepted** Text has been modified accordingly.	AMC 20-3 (6)(~~f~~e)(ii) (A) General For lightning tests, the guidelines of ~~FAA AC 20-136~~ SAE ARP 5412, 5413, 5414, and 5416 and EUROCAE ED 14/RTCA DO-160 would be applicable.
55	Pratt&Whitney	AMC 20-3 (7) (c) Uncommanded thrust or power oscillation	Replace "In general, thrust or power oscillations less than 5% of normal maximum rated thrust or power at the flight condition may be considered acceptable", with "In general, thrust or power oscillations less than 5% peak to peak of normal maximum rated thrust or power at the flight condition may be considered acceptable"	Clarification ... Distinguishes from + or ... 5% peak ... unless that was what was meant.	**Partially Accepted** The text has been changed in response to various comments. (See in particular comment 5).	N/A
56	Pratt&Whitney	AMC 20-3 (11) Programmable Logic Devices	Delete: "For systems requiring certification to levels higher than RTCA DO-254/ EUROCAE ED-80 Level D, additional validation and verification may be necessary."	It is of little benefit to warn an applicant that addition validation and verification "may" be necessary without defining what will be used to determine if it is … as well as definition of what is required in a timely manner.	**Accepted** Text has been modified accordingly.	AMC 20-3 (11) Programmable Logic Devices … RTCA DO-254/ EUROCAE ED-80 which describes the standards for the criticality

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						and design assurance levels associated with Programmable Logic Devices development, is an acceptable means, but not the only means, for showing compliance with CS-E 50 (f). ~~For systems requiring certification to levels higher than RTCA DO-254/ EUROCAE ED-80 Level D, additional validation and verification may be necessary~~. For off-the-shelf …
57	Pratt&Whitney	AMC 20-3 (10) (d) On-Board or Field Software Loading and Part Number Marking	Replace "The loading system should be in compliance with the guidelines of DO-178B." , with "The loading system should be in compliance with the guidelines of DO-178B. **Loading systems utilizing CRC checks do shall be sufficient to determine successful software loads and do not require tool qualifications.**"	It has been found acceptable that loaders with CRC checks meet the appropriate reliability requirements intended by DO-178B Level A qualification.	**Not Accepted** (See response to comment 48).	N/A
58	Pratt&Whitney	AMC 20-3 (10) (d) On-Board or Field Software Loading and Part Number Marking	Replace "For those Electronic Engine Control Systems having only one part number, which represents a combination of a software and hardware build, the unit part number on the nameplate should be changed when the new software is loaded", with "For those Electronic Engine Control Systems having only one part number, which represents a combination of a software and hardware build, the unit part number on the nameplate should be	It has been found acceptable in practice to provide a nameplate that has provisions for recording new part numbers following software loading rather than requiring removal of the previous nameplate.	**Partially Accepted** Text has been modified accordingly, with some further improvement.	AMC 20-3 (10) (d) On-Board or Field Software Loading and Part Number Marking … For ~~those Electronic Engine Control System~~ an EECS unit having only one part number, which represents a

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
			changed **or updated** when the new software is loaded."			combination of a software and hardware build, the unit part number on the nameplate should be changed or updated when the new software is loaded. The software …
59	Pratt&Whitney	AMC 20-3 (15) (a) Aircraft or Propeller …System	Need to define ATTCS.	There does not appear to be a definition for ATTCS.	**Not Accepted** Commenter should refer to § (8)(c) of this AMC where ATTCS is defined.	N/A
60	Pratt&Whitney	AMC 20-3 Various	With all the references to things that should be included in the Engine Instructions for Installation it might be helpful to create a summary table that would provide a checklist to help verify everything that should be in it.	Clarification	**Not Accepted** The proposal is out of scope of this NPA.	N/A
61	Pratt&Whitney	AMC 20-3 (6) (f) (iii) Pass/Fail Criteria	Change first bullet to 'A greater than +/- 3 % (+/- 10% for general aviation installations) change of **maximum** rated power or thrust.. '	Change removes ambiguity and produces consistency among applicants.	**Partially Accepted** Intent of the comment has been agreed. The text has been improved.	(See Response to Comments 17 and 42)
62	Raytheon	CS-Definitions Various	1)CS-Definitions Revise definition of Back-up System (Engine related definition) to contain words to the effect that it "could include less capable lane."	1) The figure titled "Definitions Visualized" in Section III, Proposed changes to AMC 20, Paragraph 4, Definitions includes the following under Back-Up System: May be Hydro mechanical Control or less capable lane. By revising the above definition for Back-up System in Section II, it would be clearer that the back up system can be considered another less capable lane.	1) **Not Accepted** **N**o need to change the definition. See Figure in §4 of AMC 20-3.	N/A

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
			2) CS-Definitions Revise definition of Electronic Engine Control System (EECS) to include mention of lanes.	2) Clarity	2) **Not Accepted** **N**o need to change the definition. This is described in the text.	N/A
			3) AMC 20-3, (4) Definitions In the figure entitled Definitions Visualized, insert EECS above the words Primary System in the box under Engine Control System.	3) Clarity. The Primary System description insinuates an Electronic Engine Control System (EECS). An EECS which is an Engine Control system in which the primary functions are provided using electronics.	3) **Not Accepted** It is considered that the counter proposal does not add to the understanding of the schematics.	N/A
			4)AMC 20-3, (6) (a) (ii) Availability Revise first sentence as follows: "If the applicant claims that there is no **loss of** thrust control/loss of power control….." (additional suggested text shown in bold)	4) Clarity.	4) **Partially Accepted** Intent of the comment has been agreed. The text has been improved.	(See proposed text in response to Comment 14)
			5)AMC 20-3 (6) (f) (iii), Pass/Fail Criteria. Include a sentence at the end of 6(f)(iii) as follows: "If the design changes are significant a retest should be performed."	5) Clarity	5) **Not Accepted** "Significant" in liaison with "design changes" is a complex subject (see "CPR" rule of 21A.101). The current practice is to re-define the certification basis when a significant change is necessary.	N/A
			6) AMC 20-3 (7) (d) (i) For turbine Engines Electronic Engine Control System should be abbreviated as ECCS as previously identified in the definitions.	6) Consistency throughout document.	6) **Accepted** Text has been modified accordingly.	(See proposed text in response to Comment 44)
			7) AMC 20-3 (9) (b) Other protective	7) Clarity	7) **Not Accepted**	N/A

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
			functions In the first paragraph of (b), the functions discussed are engine control specific, however, in the third paragraph, the functions discussed are system level aircraft functions. This should be clarified.		The text is considered to be clear.	
63	RR, UK	A. Explanatory Note IV. Discussion of the proposals	As suggested in the Explanatory Note, this AMC 20-3 will provide additional guidance to that retained in AMC 20-1. There is also further guidance for Engine Control Systems in AMC to CS-E 50 (which does not reference AMC 20-3). Consideration should be given to consolidating the two AMC 20 documents particularly since they duplicate some sections and since they will be separated in the AMC 20 structure, presumably by AMC 20-2. At the very least there should be appropriate cross-references between CS-E 50, AMC to CS-E 50, AMC 20-1 and AMC 20-3. For example consideration should be given to referencing AMC 20-3 from CS-E 50, AMC to CS-E 50 and AMC 20-1 in appropriate sections.		**Noted** Cross reference to AMC 20-3 added from several AMC to CS-E and from AMC 20-1 by means of NPA 3-2005.	(Text amended)
64	RR, UK	CS-Definitions	It would be of value to agree a definition of Aircraft-Supplied Electrical Power to explain that this means any power provided directly from the aircraft and that routed via aircraft systems. This would be consistent with having a definition of Aircraft-Supplied Data.		**Accepted** Definition has been added.	Definition added to CS-Definition (See Comment 9)
65	RR, UK	AMC 20-3 (6) (a) (i) Engine Test Considerations	The words 'for which they have lost capabilities' is a duplication and is irrelevant. Text should be deleted.		**Partially Accepted** Intent of the comment has been agreed. The text has	AMC 20-3 (6)(a)

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
					been improved. (See also comment 13)	(i) Engine Test Considerations … Some capabilities … These modes do not require engine test demonstration ~~under the adverse conditions for which thay have lost capabilities~~ as long as the installation and operating instructions reflect this loss of capability.
66	RR, UK	AMC 20-3 (6) (f) (i) Declared levels	The paragraph begins by using the term 'Electromagnetic interference and lightning'. In describing these same phenomena, it is noted that there are inconsistencies in the terminology used between this proposal, CS-E and AMC 20-1. (Among other terms, CS-E uses the term 'EMI, HIRF & Lightning' and AMC 20-1 uses terms such as 'electromagnetic disturbance' and 'Lightning and other electromagnetic effects'.) a. It is proposed that the term is standardized (starting with this document) by using 'EMI, HIRF and Lightning' wherever appropriate. b. It is also noted that in (f)(i), minimum default levels for system laboratory HIRF tests are defined. There are no default levels defined for EMI or Lightning tests however.		**a. Accepted** Text has been modified accordingly. **b. Not Accepted** The default values for HIRF are generally accepted and will provide some harmonisation with FAA practices. There are no generally accepted default levels for EMI and Lightning.	Multiple entrees made to standardise on terminology using "EMI, HIRF & Lightning".
67	RR, UK	AMC 20-3 (6) (f) (ii) (B) Open Loop and Closed	The 3rd sentence relates to open loop testing - but does not say so. Consequently, the sentence should clarify this point.		**Partially Accepted** The new format of this text (now renamed 6(e)) makes	

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
		Loop Testing.	Propose: '**In the open loop test set-up,** a simplified Engine simulation may be used to close the outer Engine loop.'		the proposed change unnecessary.	
68	RR, UK	AMC 20-3 (6) (f) (iii) Pass/ Fail Criteria.	While recognizing the logic of standardizing with other environmental tests/acceptance limits, the acceptance of up to +/-3% change in rated power following HIRF/Lightning encounters is rather different to the levels quoted in the FAA's AC33.28-1. In the AC, '+/-2% of power or thrust change from the normal control governing capability for a period of less than one second' is acceptable. This latter value has been applied to recent certification exercises and, depending on the interpretation of the phrase 'normal control governing capability', can be significantly less than that proposed in this NPA.		**Noted** It is understood that FAA will use the outcome of this EASA rulemaking activity as the basis for up-dating its advisory material. However, the new version of the FAA AC is not published and its final content is not known.	N/A
69	RR, UK	AMC 20-3 (7) (f) Commercial or Industrial Grade Electronics Parts	The 'reliability analysis' referred to in the first sub-paragraph would be better referred to as the 'LOTC/LOPC analysis' to avoid any confusion.		**Accepted** Text has been modified accordingly.	AMC 20-3 (7) … (f) Commercial or Industrial Grade Electronics Parts … - Reliability data that substantiates the Failure rate for each component used in the ~~reliability~~ LOTC/LOPC analysis and the SSA for each commercial and industrial grade electrical

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
						component specified in the design. …
70	RR, UK	AMC 20-3 (7) (f) Commercial or Industrial Grade Electronics Parts 4th Bullet Point	Where cooling provisions are required in the design of the EECS, it is not clear why the provisions should be specified in the instructions for installation where the provisions are part of the engine design. The paragraph should be amended accordingly. Propose: Additionally, if commercial or industrial parts are...specify these provisions in the instructions for installation **where the provision is required as part of the aircraft design.**		**Partially Accepted** Intent of the comment has been agreed. The text has been improved.	AMC 20-3 (7) … (f) Commercial or Industrial Grade Electronics Parts … - Commercial and industrial grade parts … the applicant should specify these provisions in the instructions for installation to ensure that the provisions for cooling are not compromised. Failure modes … …
71	RR, UK	AMC 20-3 (8) (a) Scope of the Assessment & (b) Criteria	The word 'analysis' is missing in 2 places when referring to the LOTC/LOPC analysis. (b)(ii), as written, is not understood. Propose that it is re-written as 'compliance with the agreed LOTC/LOPC rate for the intended installation - see para (7)(d) of this AMC'.		**Accepted** Text has been modified accordingly.	AMC 20-3 (8) (a) Scope of the Assessment … The LOTC/LOPC analysis described in Section 7 is a subset of the SSA. The LOTC/LOPC analysis and SSA may be separate or combined as a single analysis. …

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
						The Engine Control System SSA and LOTC/LOPC analysis, or combined … … (b) Criteria … (ii) For Failures leading to LOTC/LOPC events, ~~showing~~ compliance with the agreed LOTC/LOPC rate for the intended installation (See paragraph (7)(d) of this AMC).
72	RR, UK	AMC 20-3 (9) (a) Protective Functions (Para 1 & 2)	CS-E 50(e) is concerned with ensuring the availability of the rotor over-speed protection function. The text in paragraph (a) does not relate to achieving this objective as stated but to how engines are designed to ensure an independent protection system. - To recognise that for some designs, the Engine Control System does not provide the only means of protection against an over-speed condition it should be made clear that the paragraph applies only to those configurations where the Engine Control System provides the sole means of mitigation. (eg. the use of Critical Parts can provide mitigation in some circumstances such as TLD configurations.) The first paragraph would therefore be more appropriate to read: ~~Compliance with CS-E 50(e)~~ '**Rotor Over-**		**Accepted.** Text has been modified accordingly.	AMC 20-3 (9) (a) Rotor Over-speed Protection. ~~Compliance with CS-E 50 (e)~~ Rotor over-speed protection is usually achieved by … The following guidance applies if the rotor over-speed protection is provided solely by an Engine Control System protective function.

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
			speed protection is usually achieved by providing an independent over-speed protection system, such that it requires two independent Faults or malfunctions (as described below) to result in an uncontrolled over-speed.' The following guidance applies if the rotor over-speed protection is provided **solely** by an Engine Control System protective function.			
73	RR, UK	AMC 20-3 (12) (c) Design Assessment 5th para. 3rd sub. Para.	Since synthesised Engine parameters can be used to provide control inputs (as well as being 'voters') the text should recognize such a situation. Propose: 'Use of synthesized Engine parameters to control or as 'voters'.'		**Accepted** Text has been modified accordingly.	AMC 20-3 (12) … (c) Design Assessment … - Use of synthesised Engine parameters to control or as voters. When … …
74	RR, UK	General	While recognizing that the AMC is directed at engine issues/effects associated with electronic engine control systems, it is also noted that it makes no mention of electromagnetic emissions from the Control System and any limits that should be applied to it. (see EUROCAE ED 14 Section 21) The comment disposition team are requested to ensure that this is adequately covered.		**Partially Accepted** Aircraft certification will address such emissions from the engine. AMC 20-1 has been amended.	(See amended AMC 20-1)
75	RR, UK	AMC 20-3 (7) (b) (iii) (8) (a) & (b)	Section 8 (a) 7th sub-para. (ie. 2nd bullet) and 8(b) (iii) both appear to contradict the LOTC definition by considering cases that include loss of operability but are not LOTC events. The LOTC definition Section 7(b)(iii) - Page 23 includes such loss of		**Partially Accepted** Changes have been made to provide clarification. See § (7)(b)(ii) where such case is addressed.	N/A

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
			operability. The inconsistency should be addressed.			
76	RR, UK	AMC 20-3 (8) (a) Scope of the assessment	A further bullet point should be included to reflect the fact that Hazardous failures are identified in the SAA. Propose: '- Failures resulting in Hazardous Engine Effects'.		**Partially Accepted** "Major Engine Effects" are also included.	AMC 20-3 (8) (a) Scope of the assessment … - Failures affecting … - Failures resulting in Major Engine Effects and Hazardous Engine Effects. …
77	Hispano-Suiza	Proposed changes to CS-E	Present AMC to CS-E 50, AMC to CS-E 80 and AMC to CS-E 170 refer to AMC 20-1. These AMC should also refer to AMC 20-3.	AMC 20-3 introduced by NPA-04-2005 proposes guidance material to address Electronic Engine Controls, EMI, HIRF and Lightning and Overheat.	**Noted** Cross reference to AMC 20-3 added from several AMC to CS-E and from AMC 20-1 by means of NPA 3-2005.	(Text added)
78	Hispano-Suiza	CS-Definitions	Missing dots at the end of definitions of "Back-up Mode", "Back-up System", "Covered Fault"		**Accepted**	(Text has been modified accordingly.)
79	Hispano-Suiza	CS-Definitions	' Programmable Logic Device' should be replaced by 'Programmable Logic Device (PLD)'.	The acronym is used in page 5 of NPA, in the words defining the programmable logic devices and is commonly used in ED-80/DO-254.	**Accepted**	(Text has been modified accordingly.)
80	Hispano-Suiza	AMC 20-3 (3) Relevant Specifications and Reference Documents	Change the following titles as follows: - (Engine configuration and interfaces)" instead of "(Interfaces)". - Engine systems and component verification)" instead of "(Engine system and component tests)".	- To make the text of the Table in AMC 20-3 consistent with CS-E titles. Note that in CS-E, the title of CS-E 510 "Safety Analysis" is not consistent with the one of Table of Contents (Failure Analysis).	**Accepted** Editorial errors will be addressed by the Agency prior to publication of the next CS-E amendment.	(Text has been modified accordingly.)

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
			- (Safety analysis)" by "(Failure analysis)". Missing reference in the Table: CS-E 745 (Engine acceleration).	- CS-E 745 is referred to in §§ (8)(b)(iii) and (12)(a) of the NPA		
81	Hispano-Suiza	AMC 20-3 Table of Content	- Remove the dot at the end of the titles of sections (7)(f) and (8)(c). - Remove also the dot at the end of the titles in the text of the NPA (pages 25 and 29).	Cosmetic.	**Accepted**	(Text has been modified accordingly.)
82	Hispano-Suiza	AMC 20-3 (3) Relevant Specifications and Reference Documents	Revision or date of referenced documents should not be provided by the AMC 20-3.	- For example, ED-14/DO-160 is referenced in AMC to CS-E 80 and the version is not provided. - For ED-12/DO-178, two versions are referred to in the NPA (A and B). - In addition, version E of the DO-160 has been issued in December 2004.	**Not Accepted** (See response to Comment 6)	N/A
83	Hispano-Suiza	AMC 20-3 (4) Definitions	This paragraph states that words defined in CS-Definitions and in CS-E 15 are identified by capital letter. In the NPA the word "Engine" is always used with capital letter. Throughout the NPA, the word "propeller" is used with or without capital letter, without clear guidelines.		**Accepted**	(Text has been modified accordingly.)
84	Hispano-Suiza	AMC 20-3 (6) (a) Control modes - general	Replace "High Intensity Radiated Field (HIRF) and lightning" by "Electromagnetic Interference (EMI), High Intensity Radiated Field (HIRF) and lightning".	Use words yet present in CS-E (refer to AMC to CS-E 80, Table 2).	**Partially Accepted** Intent of the comment has been agreed. The text has been improved in response to other comments.	(See response to Comment 66)
85	Hispano-Suiza	AMC 20-3	Missing words in the present text. Replace	Clarification	**Noted**	N/A

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
		(6) (a) (ii) Availability	present text by' … that there is no Loss Of Thrust Control / Loss Of Power Control (LOTC/LOPC)' …		(See response to Comment 14)	
86	Hispano-Suiza	AMC 20-3 (6) (f) Environmental Conditions	Replace first line by: 'Environmental conditions include EMI, HIRF and lightning. The environmental conditions are addressed under CS E-80 and CS-E 170. The following provides additional guidance for EMI, HIRF and lightning.'	Improvement of the text with words introducing the section (6)(f).	**Accepted**	(Text has been modified accordingly. Now renamed 6.e)
87	Hispano-Suiza	AMC 20-3 (6) (f) (ii) (A) General	At the end of paragraph, replace "Pin Injection Test (PIT) are normally conducted on the EECS unit and 'by' .. 'Pin Injection Test (PIT) are normally conducted as components tests on the EECS unit and..'	Clarification to precise that PIT are performed at component level.	**Accepted** Text has been modified accordingly.	AMC 20-3 (6) (~~f~~e) (ii) (A) General … Pin Injection Tests (PIT) are normally conducted as component tests on the EECS unit and … …
88	Hispano-Suiza	AMC 20-3 (6) (f) (ii) (A) General	Missing dot at the end of the sentence "Pin Injection Test (PIT) … /DO-160)'	Cosmetic	**Accepted**	(Text has been modified accordingly. . Now renamed 6.e)
89	Hispano-Suiza	AMC 20-3 (6) (f) (ii) (A) General	In the last paragraph, replace '..in lieu of DO-160 tests..' ' by '.. in lieu of EUROCAE ED-14/RTCA DO-160 tests..'	Editorial comment	**Accepted**	(Text has been modified accordingly. . Now renamed 6.e)
90	Hispano-Suiza	AMC 20-3 (6) (f) (ii) (B) Open Loop and Closed loop Testing	Replace "HIRF, lightning and EMI" by "EMI, HIRF and lightning". Three (3) occurrences in the paragraph.	Use words yet present in CS-E (refer to AMC to CS-E 80, Table 2).	**Accepted**	(Text has been modified accordingly. . Now renamed 6.e)
91	Hispano-Suiza	AMC 20-3 (6) (f) (iii) Pass/Fail Criteria	- In the first paragraph, replace 'The pass/fail criteria of CS-E 170 for HIRF and lightning should..' by 'The pass/fail criteria of CS-E 170 for EMI, HIRF and lightning should..'	Use words yet present in CS-E (refer to AMC to CS-E 80, Table 2).	**Accepted**	(Text has been modified accordingly. . Now renamed 6.e)

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
			- In the last paragraph, replace '..with respect to the EMI/HIRF and lightning environment.' by '.. With respect to the EMI, HIRF and lightning environment.'			
92	Hispano-Suiza	AMC 20-3 (6) (f) (iv) Maintenance Actions	Replace '..level of HIRF and lightning,.. ' by 'level of EMI, HIRF and lightning, ..'.	Use words yet present in CS-E (refer to AMC to CS-E 80, Table 2).	**Accepted**	(Text has been modified accordingly. . Now renamed 6.e)
93	Hispano-Suiza	AMC 20-3 (6) (f) (v) Time Limited Dispatch (TLD) Environmental Tests	Replace 'HIRF and lightning tests..' by 'EMI, HIRF and lightning tests .'. Two occurrences in the paragraph.	Use words yet present in CS-E (refer to AMC to CS-E 80, Table 2).	**Accepted**	(Text has been modified accordingly. Now renamed 6.e)
94	Hispano-Suiza	AMC 20-3 (7) (f) Commercial or Industrial Grade Electronic Parts	Incorrect reference to Part 21 in last paragraph. Replace 'Part 21A101(b)(1)' by 'Part 21A.101(b)(1)'	Cosmetic	**Accepted**	(Text has been modified accordingly.)
95	Hispano-Suiza	AMC 20-3 (8) (a) Scope of the assessment	In the last bullet of 5th paragraph, change present words to: 'which may be considered aircraft functions (e.g. thrust reverser control, control of cooling air, control of fuel recirculation) or propeller functions (e.g. propeller control).'	Control of the propeller is not considered as an aircraft function.	**Not Accepted** The counter proposal has not been accepted for reasons of consistency with interface as defined in CS-E 20 : anything which is not the “engine” is considered as being the “aircraft”. It must be noted that propeller control function can be performed by an aircraft computer. It must also be noted that the thrust reverser can be declared as being part of the engine type design : then the thrust reverser control would not be an aircraft function. The text is	N/A

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
					considered as describing adequately the intent.	
96	Hispano-Suiza	AMC 20-3 (8) (b) Criteria	Missing dots at the end of (8)(b)(ii) “For Failures leading to ..'	Cosmetic	**Accepted**	(Text has been modified accordingly.)
97	Hispano-Suiza	AMC 20-3 (8) (c) Malfunctions or Failures affecting thrust or power	In the 4th paragraph, replace '10-4 events' by '10^{-4} events'	Cosmetic	**Accepted**	(Text has been modified accordingly.)
98	Hispano-Suiza	AMC 20-3 (10) (b) Approved Methods	Remove the word 'RTCA' in the first line and modify the paragraph as follows: '..the guidelines of documents RTCA DO-178A/EUROCAE ED-12A and RTCA DO-178B/EUROCAE ED-12B, hereafter..'	ED-12B is not issued by RTCA but by EUROCAE.	**Accepted** .	(Text has been modified accordingly.)
99	Hispano-Suiza	AMC 20-3 (10) (b) Approved Methods	Replace 'DO 178B' by 'DO-178B'. Two (2) occurrences.	Cosmetic	**Accepted**	(Text has been modified accordingly.)
100	Hispano-Suiza	AMC 20-3 (10) (c) Level of software design assurance	In the 3rd paragraph, replace '..software assurance level ..' by '..software level ..': Two occurrences in the paragraph.	'Software level' is used in the NPA and is commonly used in ED-12B/DO-178B.	**Accepted**	(Text has been modified accordingly.)
101	Hispano-Suiza	AMC 20-3 (11) Programmable Logic Devices	The first words of the paragraph should be changed to: 'CS-E 50(f) also applies to devices referred to as Programmable Logic Devices (PLD)'	Clarification.	**Partially Accepted** Intent of the comment has been agreed with further improvements.(See comment 116)	AMC 20-3 (11) PROGRAMMABLE LOGIC DEVICES ~~Under~~ CS-E 50 (f) ~~there are also~~ applies to devices referred to as Programmable Logic Devices. …
102	Hispano-Suiza	AMC 20 12) (b) Background	In the last bullet of 4th paragraph, change present words to: 'EMI, HIRF and lightning environments'.	Use of words yet present in CS-E (refer to AMC to CS-E 80, Table 2).	**Accepted**	(Text has been modified accordingly.)

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
103	Hispano-Suiza	AMC 20-3 (13) (b) Analysis of design architecture	In the 5th paragraph, replace "'..EUROCAE ED 14/DO-160 ..' by '..EUROCAE ED-14/RTCA DO-160 ..' and '.. DO-160/EUROCAE ED 14 ..' by '.. EUROCAE ED-14/RTCA DO-160 ..'.	Editorial change	**Accepted**	(Text has been modified accordingly.)
104	Hispano-Suiza	AMC 20-3 (13) (c) Electrical power sources	This section should be moved before present section (13)(b).	Present section (13)(c) defines the electrical power sources and these concepts are used in the present section (13)(b).	**Partially Accepted** Intent of the comment has been agreed. The text has been improved in response to other comments. (See Comment 118)	(Section 13 is re-organised to better present information. See Annex 1 below.)
105	Hispano-Suiza	AMC 20-3 (13) (d) Effects on the Engine	Replace first sentence of 2nd paragraph by: 'For Engine control functions that rely exclusively upon aircraft-supplied electrical power, the loss of electrical power may still be acceptable.'	The words 'Where a dedicated power source.. Configuration' are useless since the important is that the function rely upon aircraft power.	**Partially Accepted** Intent of the comment has been agreed. The text has been improved.	(See Annex 1 below.)
106	Hispano-Suiza	AMC 20-3 (15) (c) (ii) Interface Definition and System Responsibilities	Replace 'The software quality level ..' by 'The software level ..'	'Software level' is used in the NPA and is commonly used in ED-12B/DO-178B	**Accepted**	(Text has been modified accordingly.)
107	Hispano-Suiza	AMC 20-3 (15) (c) (iii) (A) Case of an EECS…, (15) (c) (iii) (B) Case of an aircraft…	Replace 'EMI/lightning protection levels' by 'EMI, HIRF and lightning protection levels'	Use of words yet present in CS-E (refer to AMC to CS-E 80, Table 2).	**Accepted**	(Text has been modified accordingly.)
108	FAA	AMC 20-3 A.V RIA Impacts, Safety	Do we want to point out that with the changing technology employed in engine controls, updates to the guidance is an important element in maintaining the safety levels ?	Change to context	**Noted** Intent of the comment is agreed.	(Text does not form part of the CSs.)

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
109	FAA	AMC 20-3 A.V. RIA Impacts, Economic	..the effort to agree on the acceptable means of compliance.	missing word	**Noted**	(Text does not form part of the CSs.)
110	FAA	AMC 20-3 (3) Reference documents	Was it agreed that the revision levels would not be specified ? If they are not established this needs to be addressed. As shown it would appear that all of the references are to the no change level of these documents and that is not the intent at all.	Clarification	**Not Accepted** (See response to Comment 6)	N/A
111	FAA	AMC 20 (4) Definitions	The figure showing definitions visualized needs to be fixed, the arrows do not align properly	Clarification	**Accepted**	(The figure has been modified accordingly.)
112	FAA	AMC 20 (6) (a) (ii) Availability	..is no loss of thrust control..	missing words	**Partially Accepted** Intent of the comment is agreed. Text is amended in response to other comments. (See comment 14)	N/A
113	FAA	AMC 20 (6) (e) Control Transitions	The reference to " ..failed-fixed fuel flow (constant power output).. ", is misleading. Most if not all engines will not produce a constant power at a fixed fuel flow if the environmental conditions change. This should be acknowledged	Clarification	**Partially Accepted** Intent of the comment has been agreed. The text has been improved.	AMC 20 (6) (ed) Control Transitions … In general, transition …For instance, a Fault in the Primary System may result in a "failed-fixed" fuel flow ~~(constant power output)~~ and some … …
114	FAA	AMC 20-3 (9) (a) Rotor Over-speed protection (last paragraph)	The following clarification should be added after " ..that demonstrates that the mechanical parts (this does not include the electro-mechanical parts)..'	Clarification	**Accepted** Electrical parts may be subject to random failures when mechanical parts are subject to wear.	(Text has been modified accordingly.)
115	FAA	AMC 20-3	Change to ..…level C (DO-178B) software	Clarification	**Accepted**	(Text has been modified

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
		(10) (c) Level of software design assurance (Paragraph 2)	has been found to be acceptable.'			accordingly.)
116	FAA	AMC 20-3 (11) Programmable Logic Devices	In the first line delete the word 'also' as it is unnecessary	Delete word	**Partially Accepted** Text has been changed in response to other comments.	(See Comment 101)
117	FAA	AMC 20-3 (13)(b) Analysis of the design architecture (Paragraph 3)	I am not sure of the significance of this statement	Question	**Noted** Sentence has been deleted.	(See Annex 1 below.)
118	FAA	AMC 20-3 (13) Aircraft Supplied Electrical Power	I am proposing a re-draft of the paragraph to help in the organization and flow of thoughts. In addition, the proposal has additional words to address the reliability requirements if a system is proposed that is totally dependent on Aircraft-Supplied Power. Proposal (Text Supplied)	Where a dedicated power source is part of the system configuration, the loss of some Engine control functions that relyupon aircraft-supplied electrical power may still be acceptable. Acceptability is based on evaluation of the change in Clarification Engine operating characteristics, current experience with similar designs, or the accommodation designed into the control system. Examples of such Engine control functions that have traditionally been reliant on aircraft power include: - Engine start and ignition - Thrust Reverser	**Partially Accepted.** Intent of the comment has been agreed. The text has been improved.	(See Annex 1 below.)

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
				deployment - Anti-Icing (Engine probe heat) - Fuel Shut-Off - Over-speed Protection Systems - Non-critical functions that are primarily performance enhancement functions which, if inoperative, do not affect the safe operation of the Engine. (g) Validation The applicant should demonstrate the effects of loss of aircraft-supplied electrical power by Engine test, system USA validation test or bench test or combination thereof.		
119	FAA	AMC 20-3 (15) (c) (ii) Interface Definition and System Responsibilities (4th sub-bullet)	Should say "..software assurance level..'	Clarification	**Not Accepted** Counter proposal has not been accepted to be consistent with DO 178 wording. (See Comment 106)	N/A
120	FAA	AMC 20-3 (15) (c) (iii) Distribution of compliance tasks	Caps should be set for Propeller	Format	**Accepted**	(Text has been modified accordingly.)
121	FAA	AMC 20-3 (5) General (2nd paragraph)	'Any installation limitations, operational issues, or further compliance activities needed during aircraft certification will be noted in the instructions for installation or operation, and/or the Type Certificate Data	To track further compliance activities, or FADEC design changes that are required for engine installation on the aircraft. For example	**Not Accepted** This is already addressed by means of principles of CS-E 30 (assumptions).	N/A

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
			Sheet'	installation of an engine on a single-engine aircraft may require different fault detection or mitigation than a twin-engine installation. Also some of the engine/aircraft sensors may require calibration for the installation.		
122	FAA	AMC 20-3 (10) (b) Approved methods	(Comment withdrawn by commenter).			N/A
123	FAA	CS-Definitions	Reconsider the move of the definitions to CS-Definitions	As evidenced by the need to include the parenthetical statement (Engine Related Definition) in most (and perhaps ultimately to all) of the proposed new CS - Definitions. It seems inappropriate to move these definition, which are uniquely relevant to one product, into the definitions section where they would be applicable to all products. It would seem their current location within CS-E 15 (e) is more appropriate. For example there are ultimately numerous components involved in controlling the engines which are not part of the engine type design (e.g. throttles, discrete commands, etc.). These components are thought of at the aircraft level as being part of the	**Not Accepted** Definition of words found in both AMC 20 and CS-E should be in CS-Definitions.	N/A

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
				engine control system, but by definition they would not be given the CS-E focus of the proposed definition. The proposed JAA NPA 20-9, as amended by the JAA joint airframe-engine adhoc committee, was specifically intended to focus on CS-E compliance. Hence these definitions were appropriate and acceptable in that context. If they must be moved into the CS-Definition section, they should either be revised to cover the more general use of these terms for all products, systems and function or supplemented with other terms and definitions (e.g. ICAO has been considering using "engine" for Part 33/CS-E and "propulsion" for "engines" as installed). The former option could reduce their usefulness to CS-E, but would reduce the confusion and inaccuracy inherent within the current proposal. The later option would need a "paradigm shift" by some affected organizations.		
124	FAA	IV Discussion of Proposals Discussion of	I would be remiss if I didn't repeat my standard warning about unconditional acceptance of 3% undetected thrust loss.	The proposal to unconditionally accept 3% undetected thrust loss as	**Not Accepted** Addressed in revised AMC 20-1. It is noted that a 2%	N/A

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
		proposed AMC 20-3. (Paragraph 3)		"safe" makes it a logical imperative that aircraft certification authorities use 3% as a minimum correction from the average engine when establishing certificated airplane performance. In the case of a low probability condition which is not expected to be 'common' to more than one engine on a multiple engine airplane, this conservatism could have unwarranted cost implications for operators." The main reasons for the "logical imperative" is that the risk due to the associated impacts on takeoff abort accelerate-stop distance and engine out obstacle clearance capability would otherwise go unregulated. Rather than specifying a given % as an acceptable undetected thrust loss regardless of the probability and duration; I would propose that the probability, magnitude and duration of anticipated undetected thrust loss conditions accepted during engine certification simply be documented. Then the installer could appropriately regulate the associated risk by means of the 'minimum engine performance' used to	thrust loss would likely be undetected, may be for a long time. AMC 20-3 refers to "short period" only.	

#	Commenter	Paragraph	Comment	Justification	Response	Resulting text
				establish aircraft performance and/or compliance with the aircraft level fail-safe regulations. This approach both assures acceptable aircraft performance and does not arbitrarily limit what undetected thrust loss can be accepted. This warning was given and ignored during the NPA 20-9 discussions, so you may not want to include it in your package. However, I should point out that the related 2-3% numbers have been taken out of the ARAC Recommended AC25.901-1 for just that reason.		

ANNEX 1: AMC 20-3, SECTION 13

(13) AIRCRAFT SUPPLIED ELECTRICAL POWER

(a) Objective

The objective is to provide an electrical power source ~~to the EECS~~ that is ~~at minimum~~ single Fault tolerant (including common cause~~/~~ or mode) in order to allow the EECS to comply with CS-E 50 (c)(2). The most common practice for achieving this objective has been to provide a~~n~~ dedicated ~~Engine-mounted alternator as the~~ electrical power source for the EECS. ~~However, with the increased integration of the Engine-aircraft systems and with the application of EECS to small Engines, both reciprocal~~ reciprocating ~~and turbine, use of an Engine-mounted alternator may not necessarily be the only design approach for meeting this objective. If aircraft power Faults or Failures can contribute to LOTC/LOPC or Hazardous Engine Effects, these events should be included in the SSA and LOTC/LOPC analyses.~~ When aircraft electrical power is used, ~~T~~the assumed quality and reliability levels of aircraft power should be contained in the instructions for installation.

(b) Electrical power sources

An Engine dedicated power source is defined herein as an electric power source providing electrical power generated and supplied solely for use by a single Engine Control System. Such a source is usually provided by an alternator(s), mechanically driven by the Engine or the transmission system of rotorcraft. However, with the increased integration of the Engine-aircraft systems and with the application of EECS to small Engines, both piston and turbine, use of an Engine-mounted alternator may not necessarily be the only design approach for meeting the objective.

Batteries are considered an Aircraft-Supplied Power source except in the case of piston Engines. For piston Engines, a battery source dedicated solely to the Engine Control System may be accepted as an Engine dedicated power source. In such applications, appropriate information for the installer should be provided including, for example, health status and maintenance requirements for the dedicated battery system.

(~~b~~c) Analysis of the design architecture

An analysis and a review of the design architecture should identify the requirements for Engine dedicated ~~electrical~~ power sources and ~~aircraft~~ Aircraft-~~supplied~~ Supplied ~~power~~ Power sources. The analysis should include the sources of power and the effects of losing these sources. If the Engine is dependent on Aircraft-Supplied Power for any operational functions, the analysis should result in a definition of the requirements for aircraft-supplied power.

The following configurations have been used:

- EECS dependent on Aircraft-Supplied Power
- EECS independent of Aircraft-Supplied Power (Engine dedicated power source)
- Aircraft-Supplied Power used for functions, switched by the EECS
- Aircraft-Supplied Power directly used for Engine functions, independently from the EECS
- Aircraft-Supplied Power used to back up the Engine dedicated power source

The capacity of any Engine dedicated power source, ~~which would be~~ required ~~for complying~~ to comply with CS-E 50 (h)(~~1~~2), should provide sufficient margin to maintain confidence that the Engine Control System will continue to function in all anticipated Engine operating conditions where the control system is designed and expected to recover Engine operation automatically in-flight. The autonomy of the Engine Control System should be sufficient to ensure its functioning in the case of immediate automatic relight after unintended shutdown. Conversely, the autonomy of the Engine Control System in the whole envelope of restart in windmilling conditions is not always required. This margin should account for any other anticipated variations in the output of the dedicated power source such as those due to temperature variations, manufacturing tolerances and idle speed variations. The design margin should be substantiated by test and/or analysis and should also take into account any deterioration over the life of the Engine.

~~In the case of rotorcraft, it is recognised that the Engine Control System may require aircraft power during ground operations.~~

(d) Aircraft-Supplied Power Reliability

Any Aircraft-Supplied Power reliability values used in system analyses, whether supplied by the aircraft manufacturer or assumed, should be contained in the instructions for installation.

When Aircraft-Supplied Power is used in any architecture, if aircraft power Faults or Failures can contribute to LOTC/LOPC or Hazardous Engine Effects, these events should be included in the Engine SSA and LOTC/LOPC analyses.

When compliance with CS-E 50 (h)(1) imposes an Engine dedicated ~~electrical~~ power source, Failure of this source should be addressed in the LOTC/LOPC analysis required under CS-E 50 (c). While no credit is normally necessary to be given in the LOTC/LOPC analysis for the use of Aircraft-Supplied Power ~~aircraft-supplied electrical power~~ as a back-up power source, Aircraft-Supplied Power ~~aircraft power~~ has typically been provided for the purpose of accommodating the loss of the Engine~~'s~~ dedicated power source~~supply~~. However, LOTC/LOPC allowance and any impact on the SSA for the use of Aircraft-Supplied Power ~~aircraft power~~ as the sole power source for an Engine control Back-up System or as a back-up power source would be reviewed on a case-by-case basis.

In some system architectures, an Engine dedicated power source may not be required and an Aircraft-Supplied Power may be acceptable as the sole source of power.

An example is a system that consists of a primary electronic single channel and a full capability hydromechanical Back-up System that is independent of electrical power (a full capability hydromechanical control system is one that meets all CS-E specifications and is not dependent on aircraft power). In this type of architecture, loss or interruption of Aircraft-Supplied Power is accommodated by transferring control to the hydromechanical system. Transition from the electronic to the hydromechanical control system is addressed under CS-E 50 (b).

Another example is an EECS powered by an aircraft power system that could support a critical fly-by-wire flight control system. Such a power system may be acceptable as the sole source of power for an EECS. In this example, it should be stated in the instructions for installation that a detailed design review and safety analysis is to be conducted to identify latent failures and common cause failures that could result in the loss of all electrical power. The instructions should also state that, any emergency power sources must be known to be operational at the beginning of the flight. Any emergency power sources must be isolated from the normal electrical power system in such a way

that the emergency power system will be available no matter what happens to the normal generated power system. If batteries are the source of emergency power, there must be a means of determining their condition prior to flight, and their capacity must be shown to be sufficient to assure exhaustion will not occur before getting the airplane back on the ground.

This will satisfy that appropriate reliability assumptions are provided to the installer.

(e) Aircraft-Supplied Power Quality

When ~~aircraft electrical power~~ Aircraft-Supplied Power is necessary for operation of the Engine Control System, CS-E 50 (h)(3) specifies that the Engine instructions for installation contain the Engine Control System's electrical power supply quality ~~and reliability~~ requirements. This applies to any of the configurations listed in paragraph (13)(c) or any new configurations or novel approach not listed that use Aircraft-Supplied Power. ~~This~~ These quality requirements should include steady state and transient under-voltage and over-voltage limits for the equipment. The power input standards of RTCA DO-160/EUROCAE ED-14 ~~EUROCAE ED-14/DO-160~~ are considered to provide an acceptable definition of such requirements. If RTCA DO-160/EUROCAE ED-14 ~~DO-160/EUROCAE ED-14~~ is used, any exceptions to the power quality standards cited for the particular category of equipment specified should be stated.

It is recognised that the electrical or electronic components of the Engine Control System when operated on Aircraft-Supplied Power may cease to operate during some low voltage aircraft power supply conditions beyond those required to sustain normal operation, but in no case should the operation of the Engine control result in a Hazardous Engine Effect. In addition, low voltage transients outside the control system's declared capability should not cause permanent loss of function of the control system, or result in inappropriate control system operation which could cause the Engine to exceed any operational limits, or cause the transmission of unacceptable erroneous data.

When aircraft power recovers from a low-voltage condition to a condition within which the control system is expected to operate normally, the Engine Control System should resume normal operation. The time interval associated with this recovery should be contained in the Engine instructions for installation. It is recognised that aircraft power supply conditions may lead to an Engine shutdown or Engine condition which is not recoverable automatically. In these cases the Engine should be capable of being restarted, and any special flight crew procedures for executing an Engine restart during such conditions should be contained in the Engine instructions for operation. The acceptability of any non-recoverable Engine operating conditions - as a result of these Aircraft-Supplied Power ~~aircraft power supply~~ conditions - will be determined at aircraft certification.

If Aircraft-Supplied Power supplied by a battery ~~aircraft-supplied battery power~~ is required to meet an "all Engine out" restart requirement, the analysis according to paragraph 13(c) should result in a definition of the requirements for this Aircraft-Supplied Power~~aircraft-supplied power~~. In any installation where aircraft electrical power is used to operate the Engine Control System, such as low Engine speed in-flight re-starting conditions, the effects of any aircraft electrical bus-switching transients or power transients associated with application of electrical loads, which could cause an interruption in voltage or a decay in voltage below that level required for proper control functioning, should be considered.

~~In some system architectures, a dedicated power source may not be required and an aircraft-supplied electrical power supply may be acceptable as the sole source of power.~~

~~An example is a system that consists of a primary electronic single channel and a full capability hydromechanical Back-up System that is independent of electrical power (a full capability hydromechanical control system is one that meets all CS-E specifications and is not dependent on aircraft power.). In this type of architecture, loss or interruption of aircraft-supplied power is accommodated by transferring control to the hydromechanical system. Such architectures should~~

~~also consider the effects of aircraft electrical power bus switching and bus power decays on Engine Control System operation during in-flight Engine re-starts as well as other conditions. Transition from the electronic to the hydromechanical control system is addressed under CS-E 50 (b).~~

~~Another example is an aircraft power system that could support a fly-by-wire flight control system. Such a power system may be acceptable as the sole source of power for an EECS.~~

~~(c) Electrical power sources~~

~~Utilisation of two isolated/independent aircraft buses as the means of compliance with this specification is considered acceptable.~~

~~A dedicated power source is defined herein as an electric power source providing electrical power generated and supplied solely for use by a single Engine Control System. They usually are alternators, mechanically driven by the Engine or the transmission system of rotorcraft.~~

~~Batteries are considered an aircraft-supplied electrical power source except in the case of piston Engines. For piston Engines, a battery source dedicated solely to the Engine Control System may be accepted as a dedicated power source. In such applications, appropriate information for the installer should be provided including, for example, health status and maintenance requirements for the dedicated battery system.~~

(~~d~~f) Effects on the Engine

Where loss of aircraft power results in a change in Engine Control Mode, the Control Mode transition should meet specifications of CS-E 50 (b).

For some Engine control functions that rely exclusively upon Aircraft-Supplied Power, the loss of electrical power may still be acceptable~~Where a dedicated power source is part of the system configuration, the loss of some Engine control functions that rely upon aircraft-supplied electrical power may still be acceptable.~~ Acceptability is based on evaluation of the change in Engine operating characteristics, current experience with similar designs, or the accommodation designed into the control system.

Examples of such Engine control functions that have traditionally been reliant on aircraft power include:

- Engine start and ignition
- Thrust Reverser deployment
- Anti-Icing (Engine probe heat)
- Fuel Shut-Off
- Over-speed Protection Systems
- Non-critical functions that are primarily performance enhancement functions which, if inoperative, do not affect the safe operation of the Engine.

(~~e~~g) Validation

The applicant should demonstrate the effects of loss of A~~a~~ircraft-~~s~~Supplied ~~electrical p~~Power by Engine test, system validation test or bench test or combination thereof.

ANNEX 2: REVISED AMC 20-1

AMC 20-1
Certification of Aircraft Propulsion Systems Equipped with Electronic Control Systems

TABLE OF CONTENTS

(1) GENERAL

The existing specific~~regul~~ations 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, ~~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.~~ it is issued to outline issues to be considered during demonstration of compliance with the aircraft certification specifications.
~~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 addresses the compliance tasks relating to both the Engine/Propeller and the aircraft certification.~~

(2) ~~REFERENCE~~ RELEVANT SPECIFICATIONS

~~2.1 *Engine and Propeller Certification*~~

~~Turbine Engines for Aeroplanes and Rotorcraft -~~
~~CS-E~~
~~Book 1, Section A, paragraphs E20, E30, E40, E50, E60, E90, E110, E140 & E150, E190 Section D, paragraphs E500, E510, E130 Section E, as appropriate.~~

~~Propellers -~~
~~CS-P, Paragraph P70~~

~~2.2 A~~For aircraft c~~C~~ertification, the main related certification specifications are :

- For ~~A~~aeroplane: in CS-25
  Paragraphs, 25.33, 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 r~~R~~otorcraft: e~~E~~quivalent specifications in CS-27 and CS-29.

(3) SCOPE

This acceptable means of compliance ~~provides guidance for electronic (analogue and digital) Engine and Propeller control systems, on the interpretation and means of compliance with the relevant Engine, Propeller and aircraft certification requirements.~~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 d~~D~~egree of authority of the system, the p~~P~~hase of flight and the a~~, A~~vailability of a B~~back-~~up ~~system~~System.

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

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

(4) PRECAUTIONS

~~4.1~~(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 increased use of electrical power 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 ~~must~~should therefore be taken to minimise these risks.

~~4.2~~(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 ~~by~~ Engine and ~~/~~Propellers ~~equipped with~~using hydromechanical control and protection systems.
~~This objective, when defined for the aircraft/Engine for a specific application, will be agreed with the Agency.~~ When possible, early co-ordination between the Engine, Propeller and aircraft applicants is recommended in association with the relevant authorities as discussed under paragraph (5) of this AMC.

~~4.3 *Precautions Relating to Engine/Propeller Control, Protection and Monitoring*~~

~~The software associated with Engine/Propeller control, protection and monitoring functions must have a quality level and architecture appropriate to their criticality (see also paragraph 4.5.1).~~
~~The design of the system relating to the control, protection and monitoring functions must be such as to satisfy the requirements of CS-E 50(c).~~

~~4.4 *Precautions Relating to Engine/Propeller Independence From the Aircraft*~~

~~4.4.1~~(c) Precautions relating to electrical power supply and data from the aircraft

When considering the objectives of paragraph 4 (a) or (b) ~~2~~, due consideration ~~must~~should be given to the reliability of electrical power and data supplied to the electronic control systems and peripheral components. The~~refore 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 ~~must~~are ~~be~~ 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).

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

~~The use of either the aircraft electrical power network or electrical power sources specific to the Engine/Propeller, or the combination of both may meet the objectives. Defects of aircraft input data may be overcome by other data references specific to each Engine/Propeller.~~

~~4.4.2~~(d) Local events

~~a. In designing an electronic control system to meet the objectives of paragraph 4.2, special consideration needs to be given to~~For Engine and Propeller certification, effects of local events are assessed.

~~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 Engine/Propeller 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~~should not cause a hazard to the aircraft. This will require consideration of effects such as the control of the thrust reverser deployment, the over-speed of the Engine, transients 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 ~~must~~should 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 A~~Such assessment should be reviewed during aircraft certification.~~gency.~~

~~4.5 *Precautions Relating to Failure Modes Common to More Than One Engine/Propeller*~~

~~4.5.1~~(e) ~~*System* design~~Software and Programmable Logic Devices

~~For digital systems, any residual errors not activated during the software development and certification process could cause a failure common to more than one Engine/Propeller. RTCA DO178B (or the equivalent EUROCAE ED 12B) constitutes an acceptable means of compliance for software development and certification. It should be noted however that the DO178A states in paragraph 3.3 - 'It is appreciated that, with the current state of knowledge, the software disciplines described in this document 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 full authority fly-by-wire 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.~~ 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.

~~It is outside the scope of this document 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.'~~

~~4.5.2~~(f) Environmental effects

~~Special attention should be given to any condition which could affect more than one Engine/Propeller control system. For example, incorrect operation under hot ambient conditions.~~

~~4.5.3 *Lightning and other electromagnetic effects*~~

~~Electronic control systems are sensitive to lightning and other electromagnetic interference. Moreover, these conditions can be common to more than one Engine/Propeller. 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 Engine and ~~/~~Propeller electronic control systems as well as their emissions of radio frequency energy ~~must~~are ~~be~~ detailed during the Engine and ~~/~~Propeller certification in the instructions for installation ~~an approved document~~. For the aircraft certification, it ~~must~~should be substantiated that these levels are adequate.

~~4.5.4 *Aircraft electrical power supply*~~

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

~~4.5.5 *Data exchanged with the aircraft*~~

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

- ~~i. 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~~
- ~~ii. Control system operating faults propagating via data links between Engine/Propellers (e.g. maintenance recording, common bus, cross-talk, autofeathering, automatic reserve power system).~~

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

~~4.6 *Other Functions Integrated into the Electronic Control System*~~

~~If functions other than those directly associated with the control of the Engine/Propeller, such as thrust reverser control or automatic starting, are integrated into the electronic control system, the Engine/Propeller certification should take into account the applicable aircraft requirements.~~

(5) INTER-RELATION BETWEEN ENGINE, /PROPELLER AND AIRCRAFT CERTIFICATION

5.1(a) Objective

To satisfy the CS aircraft requirementscertification 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.

5.2(b) Interface Definition

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

b. The Engine/Propeller/aircraft documents should cover in particular -

i. The software quality level (per function if necessary),

ii. The reliability objectives for Engine shut-down in flight, Loss loss of Engine/Propeller control or significant change in thrust, (including IFSD due to control system malfunction),Transmission transmission of faulty parameters,

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

iv. Engine, Propeller and aircraft interface data and characteristics, and

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

5.3(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 distribution between the different certification activities mustshould 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 mustshould deal with the specific precautions taken in respect of the physical and functional interfaces with the Engine/Propeller.

(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	- Safety objective - Software level	- Consideration of common mode effects (including software) - Reliability - Software level	
MONITORING	Independence of control and monitoring parameters	- Monitoring parameter reliability	- Indication system reliability - Independence engine/engine
AIRCRAFT DATA	- Protection of engine from aircraft data failures - Software level		- Aircraft data reliability - Independence engine/engine
THRUST REVERSER CONTROL/ MONITORING	- Software level	- System reliability - Architecture - Consideration of common mode effects(including software)	- Safety objectives
CONTROL SYSTEM ELECTRICAL SUPPLY	- Reliability or quality requirement of aircraft supply, if used		- Independence engine/engine - Reliability or quality of aircraft supply, if used
ENVIRONMENTAL CONDITIONS	- Equipment protection	- Declared capability	- Aircraft design
LIGHTNING AND OTHER ELECTROMAGNETIC EFFECTS	- Equipment protection - Electromagnetic emissions	- Declared capability - Declared emissions	- Aircraft wiring protection and electromagnetic compatibility
FIRE PROTECTION	- Equipment protection	- Declared capability	- Aircraft design