European Aviation Safety Agency

EASA Validation of FAA State of Design – Turbine Aircraft Engines
EASA Safety Emphasis Items (SEI)
Technical Implementation Procedures (TIP)

TIP Rev	SEI Issue & Date	
Rev 6	Initial Issue 22 March 2018	CS-E vs. 14 CFR Part 33

SEI #	Title	CS-E par.	Reference Document	Remarks
1	Compressor and Turbine Blade Failure	810(a)	SSD No. 13	Refer to SSD. Applicable in case of blisks.
2	Time Limited Dispatch	1030	SSD No. 14	Refer to SSD. Applicable in case of faults other than loss of EECS redundancy as TLD items.
3	ETOPS	1040	SSD No. 15	Refer to SSD. IFSD rate demonstration; service experience since EIS to be assessed if applicable.
4	Exposure to Volcanic Cloud Hazards	1050	SSD No. 16	Refer to SSD. E 1050 has no equivalent in Part 33. See acceptable means of compliance in AMC E 1050.
5	ED79A-ARP4754A EECS Development Assurance	50; 510	EUROCAE ED-79A / SAE ARP4754A	Legacy methods of demonstrating compliance to CS-E 50/CS-E 510 using development assurance techniques at the software and airborne electronic hardware levels do not adequately address potential errors in the development of Electronic Engine Control Systems. Therefore, EASA requests additional methods to reduce and mitigate development errors in the Electronic Engine Control System development process in line with the objectives of EUROCAE ED-79A / SAE ARP4754A, "Guidelines for Development of Civil Aircraft and Systems". A CRI IM may be needed for Engines intended to be installed on: ▪ Aeroplanes for which CS 25.1309 Type Certification basis is CS-25 Amendment 11 or later; ▪ Rotorcrafts for which CS 29.1309 Type Certification basis is CS-29 Amendment 4 or Later. There is no equivalent FAA policy or IP. The generic EASA CRI IM is recent and confidence building is necessary to ensure a consistent usage of EUROCAE ED-79A / SAE ARP4754A by the CA and VA when assessing the applicant's development assurance processes.

6	Development Assurance for Software & Airborne Electronic Hardware (AEH)	50	*See Appendix*	*See further details in Appendix.*
7	Icing Conditions	780	AMC E 780	CS-E Amendment 4 and Part 33.68 Amendment 34 introduced a harmonised requirement for a Critical Point Analysis (CPA) to ensure that the selected icing test conditions address all of the worst conditions found in the applicable icing envelope. AMC E 780 Amendment 4 introduced new means of compliance guidance for CS-E 780, which is not addressed by Part 33 or AC 20-147A:- ▪ AMC E 780 Paragraph 1.4 introduces specific guidance when sea-level testing is used for compliance. ▪ AMC E 780 Paragraph 5 introduces specific guidance for Engine Air Data Probe Icing These aspects of CS-E 780 compliance are therefore identified as an SEI until experience of applying the CPA requirements has been gained, and pending introduction of harmonised guidance in Part 33 or AC 20-147 addressing sea-level testing and air data probes.

Notes:

1. New technology, and novel applications of existing technology, as defined in the TIP, are deemed to include new, novel or unusual materials and manufacturing process (CS-E 70 refers), such as, but not limited to, additive manufacturing, use of ceramic composites etc.

   As those should be captured within the non-basic classification criteria for changes and the technical validation process, an SEI is not raised for these aspects. However in this frame relevant EASA policies and potential differences with FAA policies should be reviewed for applicability.

SEI Part 2:

For the following SEI, FAA is deemed to have gained sufficient experience at time of issuance of this list. EASA will therefore accept FAA's verification of compliance with these items.

SEI #	Title	CS-E par.	Reference Document	Remarks
8	Turbine Over-speed Resulting from Shaft Failure	840; 850	CM PIFS-003	No equivalent FAA policy to EASA CM-PIFS-003. The CM clarifies AMC E 850 (2) by detailing the considerations to perform a test for demonstrating the "Non-Hazardous Shaft Failures" in compliance with CS-E 850 (b)(1), and addressing specifically turbine overspeed resulting from shaft failure. Also if compliance is proposed by analysis it clarifies what conditions would be acceptable to the Agency.
9	Damage Tolerance Assessment	515	CM-PIFS-007	EASA CM-PIFS-007, paragraph 3.1.A1.(c) states: "The assumptions used in this analysis (i.e. material properties, reference engine cycle, operating environment and its effect on the stress cycle etc.) should be declared." Change 1 of FAA AC 33.70-1 revised the applicable requirements to define the damage tolerance cycle as the major stress cycle (min-max-min) from the missions used in the LCF certification analysis for standard day conditions. For EASA the engine flight cycle analysed should include the various flight segments that describe a complete mission such that detrimental effects are appropriately evaluated. Examples of such affects are dwell and minor cycles.
10	Turbine Engine Relighting In Flight	910	CM-PIFS-010	FAA Policy PS-ANE-33.89-1 is not applicable to turboshaft engines. It also does not specifically address "Quick engine shut-down and relight". EASA CM-PIFS-010 is applicable to all turbine engines, including turboshafts. Paragraph 3.1-1 requires the applicant to justify that the engine design, and in particular the engine control system, will not introduce an unnecessary delay in the engine returning to the previous power setting.
11	Integrity of Nickel Powder Metallurgy Rotating Critical Parts for Gas Turbines	515	CM-PIFS-013	No equivalent FAA policy to EASA CM-PIFS-013. This SEI should be applied if the applicant has no sufficient design or service experience in powder metallurgy rotating critical parts.
12	Fire Testing – Burner	130	*See Appendix*	No equivalent FAA policy. *See further details in Appendix.*
13	Fire Testing – Fireproofness of Firewalls	130	*See Appendix*	No equivalent FAA policy. *See further details in Appendix.*

Appendix

Guidance for EASA/FAA SEI

CS-E vs. CFR 14 Part 33

SEI #6 Development Assurance for Software (SW) & Airborne Electronic Hardware (AEH)

The following text describes the individual SW&AEH subjects for SEI. Their applicability is dependent from the applicable MoC on projects.

ID	Subject	Description	EASA position
#6-01	Management of Open Problem Reports	Open Problem Report management guidance is needed if an applicant or any of their suppliers intends to defer the resolution and correction of AEH or Software problems past the date of certification. This subject qualifies as an SEI when insufficient guidance is applied to a project. Note: this SEI addresses only the process aspects of OPR management aspect and does not imply a specific involvement in the review of OPRs for specific systems of the product.	A means of compliance CRI is needed when guidance is insufficient. Note: SEI not applicable for validation of FAA approved products when an equivalent OPR management FAA IP or DO-178C DP#9 has been applied to the project. **Applicable references for EASA**: CM-SWCEH-001 and CM-SWCEH-002 section 16.
#6-02	Use of Multicore Processors	Additional guidance on use of Multi-Core Processors is needed for new or modified airborne systems containing Multicore Processors devices, hosting Software components on different cores. This subject qualifies as an SEI when insufficient guidance is applied to a project.	Multi-Core processors include features that may impact the behaviour, and therefore the safety, of a system if not well managed. A means of compliance CRI is needed for new or modified airborne systems containing Multicore Processors devices, hosting Software components on different cores, when guidance is insufficient. Note: SEI is applicable - when FAA Generic MCP IP rev 11 (or later) has not been applied - or when the type of MCP usage is not covered by the FAA IP (e.g. dynamic allocation). **Applicable references for EASA:** Generic EASA MCP CRI Issue 3.0

#6-03	Software Guidance	Additional guidance is needed for the development of new or modified airborne systems/equipment containing Software, when harmonized FAA/EASA guidance has not been applied. This subject qualifies as an SEI when insufficient guidance is applied to a project.	A means of compliance CRI is needed for new or modified airborne systems/equipment containing Software, when insufficient Software development assurance guidance has been applied to a project. Note: SEI not applicable - when AC 20-115D has been applied, - or when DO-178C has been applied, - or when DO-178B has been applied with use of Software techniques for which specific guidance has been raised by the CA (MBD, OOT, FM, CM/PDI, Pseudocode) - or when DO-178B has been applied without use of specific Software techniques (MBD, OOT, FM, CM/PDI, Pseudocode). Applicable references for EASA: the means of compliance CRI will cover, as applicable, guidance extracted from some Software CM-SWCEH-002 sections that are related to the applicable Software techniques.
#6-04	Hardware Guidance for custom devices	Guidance is needed for the development of new or modified airborne systems/equipment containing custom devices. This subject qualifies as an SEI when insufficient guidance is applied to a project.	Without following a structured development process, it cannot be guaranteed that the system/equipment will perform as intended with an acceptable level of confidence. A means of compliance CRI is needed for new or modified airborne systems/equipment containing custom devices (PLD, FPGA, ASIC), when no AEH development assurance guidance has been applied to a project. Note: SEI not applicable when DO-254/ED-80 associated with the FAA Order 8110.105 has been applied. **Applicable references for EASA:** CM-SWCEH-001 section 8
#6-05	Use of COTS IPs	The use of COTS IPs requires specific guidance that is not available in current material.	FAA order 8110.105 and EASA CM-SWCEH-001 do not cover COTS IP with adequate guidance, considering the nowadays complexity and usage of COTS IPs in projects. Given the impact of use of COTS IP on the overall safety level of an aircraft, a means of compliance CRI is needed for new or modified airborne systems/equipment using COTS IP in custom devices. Note: SEI only applicable for DAL A, B, C hardware.

#6-06	Use of complex COTS devices	Development assurance is needed for the usage of complex COTS devices.	Given the impact of use of COTS devices on the overall safety level of an aircraft, a means of compliance CRI is needed for new or modified airborne systems/equipment using COTS in custom devices. Note: - SEI only applies for complex COTS - SEI not applicable for COTS processor devices when FAA IP on COTS processors has been raised. **References for EASA:** COTS guidance is available in CM-SWCEH-001 section 9, however a MoC CRI would be raised with new objective oriented wording.
#6-07	Artificial Intelligence and Machine Learning	The use of Artificial Intelligence / Machine Learning requires specific guidance that is not available in current material.	The use of Machine Learning creates certification challenges and Development Assurance considerations. These type of systems may not be fully specified or even be non-deterministic, and thus, may not be able to satisfy all development assurance process objectives. Traditional Development Assurance methodologies are not adapted to the challenges raised by the verification of adaptive/intelligent systems and by the learning aspects of this new technology. To date, guidance does not exist.
#6-08	MBD for Hardware Development	The use of Model Based Development (MBD) within the development process of custom devices requires specific guidance that is not available in current material.	MBD for hardware is a new development technique with limited experience in the Hardware industry. The requirements capture and the development of the model, associated with the usage of tools to generate detailed design has a potential impact on the overall safety of the aircraft. To date, guidance does not exist.

SEI #12 CS-E 130 Fire Testing – Fire Burner

<u>Statement of Issue / Discussion</u>

Engine Fire Protection requirement is given in CS-E 130.

The acceptable means of compliance for CS-E 130 is currently stated in AMC to CS-E 130 (4)(a), test equipment and calibration as follows:

> *Acceptable procedures for calibration of the relevant burners for the tests, and the standard flame, are defined in ISO 2685 standard.*

This requirement requires a certain level of capability to withstand fire effects, either through a fire resistance or a fire proofness characteristics.

Compliance demonstration of this capability could be performed, but not uniquely, through testing. ISO 2685 is an EASA accepted guidance material for conducting fire testing in compliance demonstration of fire resistance / fire proofness.

ISO 2685, as its equivalent in 14 CFR Part 33 through AC 20-135, is considering representative environmental conditions to be imposed onto the component / specimen / system / structure under a fire situation.

ISO 2685 as of today is offering two types of burner to represent a “standard-flame”: with a gas burner or a fuel burner. A test campaign by DGA TA (Refers to International Aircraft System Fire Protection Working Group presentations on FAA Fire Safety Branch website) put into evidence that, under particular test conditions, a gas burner resulted in less severe flame effect onto the specimen in comparison with a fuel burner.

Finally the EASA/FAA-TC/DGA survey revealed results variability across testing facilities when conducting fire testing on a same sample.

EASA Position

In spite of the afore-mentioned concerns over gas burner severity and while EASA recommends the systematic use of liquid fuel burner, there is no compelling reason why credit should be taken away from fire testing conducted up to now on existing components. Therefore, when determining what burner is to be used for fire testing, one should first and foremost consider the degree of novelty in the component technology and the pedigree of its material. Hence, the following policy applies:

- For reused components or change to component and provided that this is adequately justified, the burner type used for previous fire testing (gas or liquid fuel burner) may be acceptable.
- For new components, a liquid fuel burner should be used unless supporting evidence can be presented to justify that a gas burner would produce at least as severe test results. Consideration may be given, for example, to the component size or the burner orientation. Such supporting evidence should be based on adequate comparison test data.

Prior to conducting fire testing for the purpose of complying with CS-E 130, a thorough justification of the burner type(s) to be used should be provided by the Applicant and agreed by the Agency.

SEI #13 CS-E 130 Fire Testing – Fireproofness of Firewalls

Statement of Issue / Discussion

This policy is applicable when the applicant for an engine Type Certificate establishes compliance with CS-130(d). It describes how the firewall requirements may be interpreted at Engine level and are coordinated with Aircraft level requirements.

The need to address the fireproof capability when an engine is shut-down-static on-ground is a concern for the Aircraft certification but is not reflected in either CS-E or CS-Definitions (which imply engine operation only). This is particularly significant when planning fire testing for firewalls that separate a fire zone from an engine duct, such firewalls will be subject to significantly different conditions between engine-operating and engine-shut-down-static due to the changes in pressure loading and backside air flow.

CS-E 130(d), CS 25.1191(b) and CS 29.1191(e) require firewalls to be Fireproof, without further qualification.

CS-E 130(a) requires that the probability of occurrence and spread of fire during normal operation, and under failure conditions, is minimised.

FAA AC 20-135 provides unique detailed guidance to define acceptable fire test conditions to applicants for FAA certification. This document identifies the pressure loading during critical power operating conditions as a key test condition for firewalls that separate a fire zone from an engine duct (section 7.b.(1)(iii)).

EASA Position

When fire testing is part of the demonstration of compliance, AMC E 130 and FAA AC 20-135 should be used to define acceptable test conditions.

A component forming part of the engine type design under CS-20(a), designed, constructed and installed to act as a firewall in accordance with CS-130(d), should be shown to withstand the application of heat by a flame as defined for "'Fireproof" for a period of 15 minutes, in conditions simulating the most severe normal operating, and failure, engine conditions. Consistent with FAA AC 20-135, it is accepted that normal operation corresponds to an engine operating or windmilling in-flight, or operating on-ground.

For aircraft certification, engine firewalls may additionally be required to demonstrate capability on the ground after the engine shut down. If it is required for a particular installation, the CS-E 130(d) engine certification test may be carried out to address these conditions, where it can be shown that the test is no less severe.

The engine components certified as firewalls should be listed, including their capability in terms of demonstrated conditions and time, in the instructions for installing the engine required by CS-E 20(d).