Report of the Engine/Aircraft Certification Working Group

Final

9 June 2017

Contents

1 Executive Summary

By exchange of letters in February and March 2016, European Aviation Safety Agency (EASA) and Federal Aviation Administration (FAA) leadership agreed to form a joint Engine and Aircraft Certification Working Group (EACWG) to look at improving engine/aircraft interface certification practices. The group was tasked to conduct an in-depth review of current certification practices and processes, and to develop recommendations for EASA and FAA leadership by June 2017 on changes that would streamline and improve the overall certification process. The group held its kick-off meeting in May 2016, met in person several times thereafter, and conducted monthly phone calls over the following year to progress action items and evaluate data as it became available.

During recent aircraft certification programs some engine-related issues have been raised by airworthiness authorities and applicants, even though the engine had been approved and held its own type certificate (TC). These issues have included technical matters indicating possible inconsistencies between the engine and aircraft certification requirements with apparently redundant or seemingly conflicting aircraft and engine airworthiness requirements. As a result, certification programs have been unnecessarily burdensome. Procedural matters were also highlighted by the group, such as poor communication between engine and aircraft TC holders and the associated airworthiness authority staff, and interdependencies of the aircraft and the associated engine certification programs not being well aligned.

The group focused on turbine engines installed in transport category aircraft and was limited to FAA and EASA staff with industry representatives from the US and European engine and aircraft manufacturers. The group developed a questionnaire to gather feedback from industry and airworthiness authority stakeholders not directly represented in the EACWG.

To conduct a thorough review, the group used several approaches: brainstorming, a questionnaire, and a comparison of turbine engine airworthiness requirements in Title 14, Code of Federal Regulations (CFR) part 33 and Certification Specifications for Engines (CS-E) with the engine installation-related transport-category aircraft airworthiness requirements in 14 CFR part 25 and CS-25. Through brainstorming, the group discovered numerous specific issues that could be improved, in six general areas:

- Communication and timing;
- Duplication of work;
- Gaps in requirements;
- Process;
- Rules and interpretation; and
- Technical and general.

The group developed a questionnaire (issued by EASA) to obtain input in these areas, and received detailed responses from 19 separate stakeholders, including those represented in the EACWG. Independent of those efforts, a sub-group reviewed existing engine and aircraft-level regulations and guidance to determine whether any propulsion and powerplant-related gaps, overlaps, or conflicts existed.

The group concluded that the current certification process delivers safe products; however, there is room for coordination improvement and efficiency gains. An effective and efficient process where all parties can concentrate on the important topics can only have safety benefits. The group did not see a need for an overall change in approach. Specifically, the group reached consensus that engines and aircraft should continue to be certified under separate TCs. It was clear that the engine and aircraft manufacturers share a common objective, which is to place maximum reliance on the engine TC and avoid duplicating work at the aircraft level, thus ensuring continuity in airworthiness requirements. While the group found that no radical changes to the certification process are required, they did find that increased coordination between engine and aircraft airworthiness authorities is necessary.

The group also found several specific issues that should be addressed. Examples include gaps in fire prevention guidance, a lack of clarity on the application of 14 CFR part 25 and CS-25 electrical wiring interconnection systems (EWIS) requirements to 14 CFR part 33 and CS-E engine wiring, confusion over the application of SAE International Aerospace Recommended Practice (ARP) 4754A/ED-79A to engine control systems, and whether an aircraft manufacturer can disable engine protection systems required for 14CFR part 33 and CS-E certification. The group proposes future tasks to address these specific issues.

In addition to the specific issues above, the group determined that there is a need to improve clarity during the rulemaking process, with respect to whether an aircraft requirement should apply to the engine type design. A regulatory process needs to be developed to address gaps in regulations and guidance that are found either because of omissions during the development of the original guidance or when new technology is used. Procedural requirements should be put in place to ensure early and continual communications between engine and aircraft authorities when considering special conditions that affect engine and aircraft interface issues (such as engine ratings). Finally, a process should be put in place for aircraft and engine manufacturers to escalate questions, for example about new or revised certification requirements placed on them after a product certification basis has been set. The group proposed short-term ways of addressing these issues, and long-term future tasks to implement permanent solutions.

The group identified a total of 29 recommendations for follow-on action. Several of the recommendations are supported through separate activities that have already been launched, and one recommendation was completed as part of the group's activities.

There were a few recommendations that were beyond the scope of this group, but which the group believed were appropriate for further work. The group recommended that the airworthiness authorities should consider the need for a similar activity to be conducted on other product types (such as propeller, General Aviation aircraft, and rotorcraft) and auxiliary power units (APUs). This approach might help to improve the efficiency and effectiveness of future certification programs for various product lines.

The recommendations are restricted to certification and regulatory activities conducted by the authorities or by the authorities and industry. The group has not made recommendations that relate to activities between aircraft and engine manufacturers, leaving it to the manufacturers themselves to use the group findings to address any areas for improvements. Although no specific recommendations in this report address existing responsibilities of the airplane and engine

manufacturers, it is critical to the success of each type certification program that the manufacturers work closely and communicate effectively with each other to ensure they share a mutual understanding of airplane and engine compliance requirements. Their mutual success relies upon sharing information, communicating issues and working together to resolve issues with each other in a timely fashion.

The group has prioritized the recommendations and proposed a plan to implement them for the FAA and EASA leadership to consider. The group recommended that a follow-on joint EASA/FAA/Industry group should be formed to monitor the successful implementation of the recommendations, and this is included in the final list of recommendations.

2 Tasking of the Working Group

Engines have had their own type certificates for many years, and although this has some obvious advantages, such as ensuring a focus on the safety of the engine, it may also have some disadvantages or limitations. As aircraft systems become ever more complex, and noting that turbine engines are more and more tailored for specific aircraft types, it may be that changes to the EASA and FAA regulatory systems at the engine and aircraft boundary are needed to improve efficiency and avoid the types of problems seen on some recent certification programs. To explore this issue, and propose a way forward, EASA and FAA leadership agreed, by exchange of letters in February and March 2016 (see Appendix A), to form a joint EACWG to look at the future of engine/aircraft certification. The group was tasked to conduct an in-depth review of current certification practices and processes, and to develop recommendations by June 2017 on changes that would streamline and improve the overall process. The group focused on turbine engines installed in transport category aircraft.

The formal group was limited to FAA and EASA staff with industry representatives from the US and European engine and aircraft manufacturers (see Appendix B for a list of group members). The group developed a questionnaire to gather feedback from industry and airworthiness authority stakeholders not directly represented in the EACWG.

3 Engine and aircraft certifications

In order to make recommendations for improvements, the team first ensured that it fully understood the current system. A summary of the key points of the current system, with respect to the working group's remit, is given here, to help the reader understand the starting point for the recommendations.

3.1 Two Type Certificates

In the USA and Europe, as in most other countries, engine and aircraft are defined as different products. This allows engines to be developed to suit a range of aircraft. It also recognizes the complexity of gas turbine engines and the need for coherent well-resourced organizations to design and manufacture safe products. The industry has evolved with separate, usually fairly large, companies developing aircraft and gas turbine engines. Separate TCs are issued once the respective applicant (the engine or aircraft manufacturer) has demonstrated compliance with all the applicable requirements. The airworthiness standards establish the minimum standard for safety. In addition to aircraft and engines, stand-alone TCs are issued for propellers in both the USA and Europe. Other systems or major changes to an aircraft usually incorporated by someone other than the original type certificate holder

can be certified separately, by means of a supplemental type certificate (STC). Each STC is associated with a particular aircraft product. Equipment can also be approved as meeting a safety standard through issuance of a Technical Standard Order (TSO). If TSO equipment is installed on an aircraft it must be included in the bill of materials covered by a type certificate, with the TSO approval providing evidence to support type certification. While equipment approved under a TSO meets safety standards, there are often additional airworthiness requirements that must be met when the equipment is installed.

The existence of an engine TC is a prerequisite for the issuance of an aircraft type certificate. It is common practice for aircraft manufacturers to request that the engine receive TC approval before the first flight of a new prototype.

After TC, both the engine and aircraft manufacturers are responsible for ensuring the continued airworthiness of their products.

3.2 Strong interdependencies

Aircraft cannot fly without engines providing power (motive and ancillaries). The interactions between the two products are therefore complex, from the development, certification, and service operation perspectives.

Aircraft and engine certifications are independent processes, with strong interactions. The exchange of information between the applicants and between each applicant and the regulator is managed through verbal communication and formal specific certification documents, such as the installation manual. Other, non-regulatory, interfaces are addressed under contractual agreements between the manufacturers, including the specifications (or detailed interface control documents).

From a regulatory point of view, an engine must comply with its certification basis (based upon 14 CFR part 33 and CS-E). Once installed, as per §25.901(a) the engine is part of the powerplant installation which belongs to the airplane TC and has to comply with the aircraft certification basis (based upon 14 CFR part 25 and CS-25). This situation is further discussed in the report.

Aircraft and engine manufacturers are responsible and accountable for showing compliance with all applicable airworthiness standards of 14 CFR part 25 / CS-25 and 14 CFR part 33 / CS-E, respectively. For aircraft manufacturers, this responsibility includes providing evidence that the engine and its installation meet all applicable 14 CFR part 25 / CS-25 standards. It is clear that timely and frequent communication between the aircraft and engine manufacturer is critical to preclude potential integration-related issues. Successful aircraft and engine certification is impossible without this and without coordinating the requirements between the engine and airplane manufacturers. Aircraft and engine manufacturers should continue working together to minimize interface problems, and raise regulatory or guidance issues to airworthiness authorities as they arise.

Each product, whether an aircraft or an engine, is certified by the relevant state of design, therefore companies based in the USA will have their products certified by the FAA, as the airworthiness authority in the USA, and companies based in Europe will have their products certified by EASA, as the airworthiness authority for the European Union Member States. Each product will be certified in

accordance with the certification code applicable in its state of design. The certification codes for both aircraft and engines in the USA and Europe are largely, but not entirely, harmonized. Where an aircraft manufacturer intends to install an engine certificated by a different state of design, the engine must be -validated by the certification authority of the aircraft state of design; that is the validating authority will issue a certificate stating that the engine meets the certification codes in that country, following the presentation of appropriate evidence by the engine company or acceptance by the authority of equivalence to the state of design's finding. There is a bilateral aviation safety agreement in place between the USA and the European Union which aims to simplify the validation process allowing each authority to rely on the other's findings to the maximum extent possible.

3.3 Industry organization

As stated above large transport aircraft and gas turbine engines are typically designed and manufactured by different, usually sizeable, companies, which are able to maintain full competence to produce these very complex products and to carry out the research and development to define and introduce new technology that will benefit the flying public and maintain the focus on product safety.

The way industry is organized supports the introduction of propulsion technologies and developments on many platforms.

3.4 Authority organization

Typically, authority organizations reflect the regulatory structure, with separate teams, departments or directorates being responsible for aircraft and engine type certification. This enables authorities to develop and maintain expertise in the different disciplines required for aircraft and engine design as well as accumulating domain knowledge. As they have the relevant expertise the teams responsible for certification usually cover continued airworthiness as well.

At EASA, the activities for the initial and continued airworthiness of engines and large transport aircraft are performed by two departments (CT4 and CT1, respectively) of the Certification Directorate.

At the FAA these functions are currently performed by the one engine and three aircraft directorates in the Aircraft Certification Service as defined in FAA Order 8100.5.

3.5 What is changing

When carrying out its work, the group considered how the aerospace industry is evolving to try to ensure that their recommendations will be appropriate for the future environment. This section identifies the elements of that evolution that may be relevant to the engine and aircraft interface.

- Growth in the industry is introducing new applicants as well as increasing the authority workload from existing applicants.
- The increasing pace of programs is impacting the workload for both applicants and authorities.
- The boundaries between propulsion and aircraft systems are becoming increasingly blurred due to advances in technology, higher levels of integration between design architectures and business level agreements on hardware ownership between companies.

- Authority practices are changing, with the intent to move toward more and more delegation between bilateral partners and increasing delegation to engine and aircraft company design organizations.
- International partnerships introduce challenge by increasing the need for cross authority interactions. This is likely to include more countries which are relatively new to the initial certification of engines and aircraft.
- The industry continues to achieve ever higher levels of safety which result in heightened expectations in the industry and in the public.
- The industry is becoming more complex and globally connected with technology evolving at a tremendous pace.

The above aspects of evolution within the industry underscore the need to continue to identify efficiencies and process improvements within the existing certification system.

3.6 Future State –how things should work

The desired future state of certification processes should be one where compliance with the applicable airworthiness standards can be shown and found in an efficient way for all parts of the final aircraft system. The future state should ensure that the air transportation system will continue to provide the public with safe, economical, and environmentally responsible air travel.

This future state depends on consistency and close integration between the certification standards, interpretations, and requirements that apply to aircraft and engines. Consistent and integrated requirements will maximize the benefit of TCs, prevent redundancy and make efficient use of resources. Strong communication between the airworthiness authorities' technical specialists in engine and aircraft technology, and the relevant engineering staff for the industry, will ensure that when issues arise they are resolved effectively and will prevent future conflicts, overlap and redundancy in the certification process.

The recommendations in this report are intended to move the certification process towards this future state.

4 Team Process

4.1 Problem scope and brainstorming

The EACWG first met and discussed the scope of the issue. In particular, the group discussed whether it would be advantageous to combine aircraft and engine TCs into one. During the same meeting the group developed a list of 19 recent integration issues, through brainstorming based on group members' experiences. The group categorized the issues into six general areas: communication and timing, duplication of work, gaps in requirements, processes, rules and interpretation and technical.

At the conclusion of the first meeting, the group agreed to several principles that should ideally be followed with respect to engine and aircraft integration airworthiness requirements (see paragraph 6.3 for more details).

4.2 Part 33/CS-E – Part 25/CS-25 review – regulatory interdependency and gap analysis

Another method the group used to evaluate potential regulatory engine installation issues was to conduct a regulatory interdependency and gap analysis. A sub-group generated a table listing all the FAA 14 CFR part 25, part 33, EASA CS-25 and CS-E airworthiness requirements related to engines and engine installations. The sub-group evaluated each regulatory area to determine whether there was interdependency between the aircraft and engine airworthiness requirements. Where interdependency was found, the engine and aircraft members of the sub-group described the interdependency from their respective points of view. The sub-group then evaluated these descriptions to determine whether there were gaps (missing airworthiness requirements or guidance), redundant airworthiness requirements, or different interpretations between the aircraft and engine authorities. The sub-group compared the resulting list of issues with the issues already generated during the main group's brainstorming sessions. The sub-group proposed recommendations for resolving the new issues to the main group. The regulatory review resulted in eleven additional recommendations.

The regulatory interdependency and gap analysis is shown in Appendix C.

4.3 Stakeholder questionnaire

Due to the short timeframe and the potentially large group of stakeholders, it was impractical to include all airworthiness authorities, engine industry and aircraft industry stakeholders in the group. Therefore, to ensure all stakeholders could still provide input, the group produced a survey in the form of a questionnaire to obtain feedback from a larger group of stakeholders. The survey included questions regarding the 19 issues developed from brainstorming during the group's first meeting, 14 general questions (such as what should be expected from a certified engine), what the engine certification process should look like in the future, open-ended questions on specific certification experiences, and demographic questions. EASA sponsored the survey and collected the responses. The group received inputs from 19 stakeholders and analysed the data from the survey, using it to guide the final recommendations.

The survey is shown in Appendix D and the detailed comments in Appendix F.

4.4 Results and prioritization

As a result of the above activities, the group developed 29 recommendations. To ensure that all the viewpoints of the group were incorporated, the group debated and evaluated each recommendation before agreeing on its final wording. Sub-groups were assigned to evaluate the potential benefit from each recommendation, estimate the time needed to complete it and the resources required, and propose a priority for each one. The group then reviewed the entire list of recommendations and classified them as high, medium or low priority. The group intended the FAA and EASA leadership to use the benefits, resources and priorities of the recommendations as advice for managing the long list of recommendations; however, the group considers that all the recommendations will contribute towards a successful future state.

5 Results

5.1 Summary of data used to obtain results

By following the process outlined in the previous section the group obtained a view of how well the certification and validation processes, particularly at and across the engine and aircraft interface, are working today. While the focus was on certification and validation by the FAA and EASA (or vice versa), inputs from both Transport Canada Civil Aviation (TCCA) and the Agência Nacional de Aviação Civil (ANAC) as well as organizations that have products certified by these authorities were obtained through the questionnaire. This means that the results suggest recommendations that are of value to other certification and cross-validation programs. The information obtained also considered areas which may drive the need for future change in how the engine and aircraft interface is managed during certification on other product types.

The data gathered is as follows:

1. The list of issues identified by the group through brainstorming based on their experience at the first meeting.
2. The results of the questionnaire – with input from 19 groups including regulators, aircraft and engine manufacturers.
3. The results of the regulatory interdependency and gap analysis between engines (14 CFR part 33 and CS-E) and aircraft (14 CFR part 25 and CS-25).

The rest of this section identifies the messages gathered from this data, and makes several recommendations for changes arising from this understanding.

5.2 Assessment of the current system and general areas for improvement

One of the first questions that the group discussed was whether the current system for engine and aircraft certification, with typically separate engine and aircraft TCs, is working, or whether there is a need for a fundamental change in approach. It was agreed, by all, based on individual experience, that with regards to the key message, of whether certificated aircraft, with all their systems including the engine, are safe, the current system is working. This is backed up by overall safety statistics for Civil Air Transport aircraft, as shown in Figure 5-1 and Figure 5-2. This is also backed up by the results of the questionnaire that asked what should be expected of a certified engine and whether that expectation is being achieved.

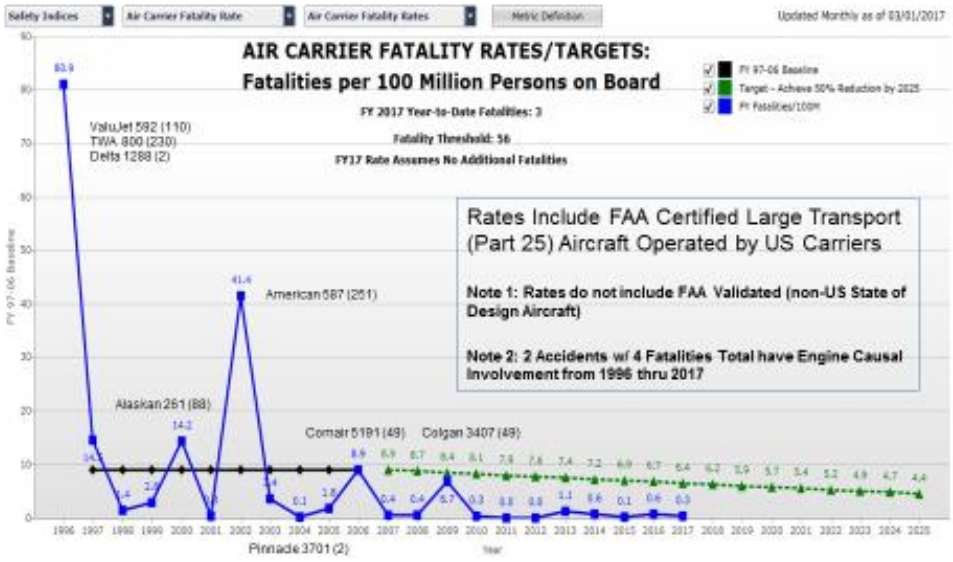

Figure 5-1: Civil Air Transport fatalities – FAA certified products (Source: FAA Office of Aviation Safety US air carriers)

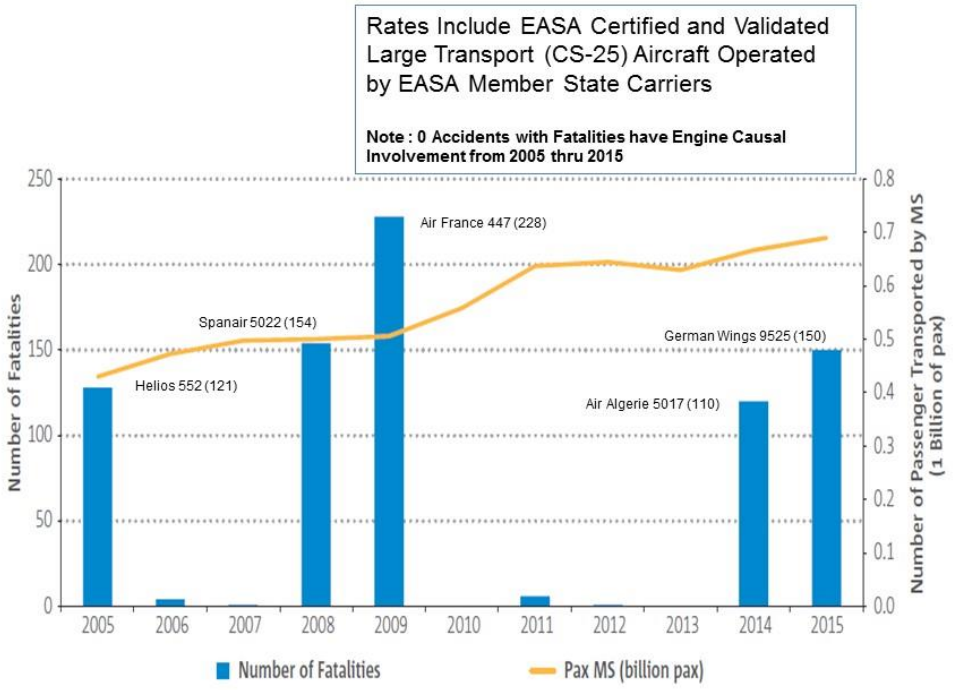

Figure 5-2: Civil Air Transport fatalities per billion passengers transported 2005-2015 (EASA member states) (Source: EASA Annual Safety Review 2016)

The group also asked what the main benefits – and disadvantages - were of a key facet of the current system--that is, of having separate TCs for aircraft and engine. The view of the group was that separate TCs should be retained. The question of whether having an engine TC is beneficial was also asked in the questionnaire, with the same response. The reasons identified for this are:

- Having an engine TC supports aircraft safety by ensuring industry engine experts retain responsibility for the initial and continuing airworthiness of engines, ensuring authorities have expertise on engines, and helping industry engine experts get access to operators.
- Having an engine TC de-risks the aircraft certification program.
- Having an engine TC allows the management of intellectual property for engines and is consistent with the aerospace industry landscape.
- Having an engine TC facilitates the use of engines on different aircraft.
- Having an engine TC allows the effective management of engines through competent organizations having design organization approval (DOA) privileges.
- Having an engine TC helps maintain the pool of engine experts.
- Having an engine TC makes the state of design for the engine responsible for certification and continued airworthiness.
- Engine and aircraft business models.

However the group recognized that having two separate TCs, each with its own set of requirements, means that some interface areas must be managed by the authorities and by the engine and aircraft manufacturers. In particular, all parties must not lose focus on the fact that engines are there to be installed in and to power an aircraft, and that airworthiness requirements and guidance must be consistent between aircraft and engine certifications.

Having formed the view that the current system produces safe products, and that the construct of having separate aircraft and engine TCs is sound, the group then considered where there was room for improvement. The group was unanimous in agreeing that there are inefficiencies in the system that can lead to resources being wasted and to activities taking longer than necessary. From a business, and authority resources perspective it is important to address these issues while maintaining or improving the current safety level. Following a brainstorming activity, six areas were identified where there is room for improvement namely communication (whether between original equipment manufacturers, authorities, within an authority or across the manufacturer/authority boundary), duplication of work, timing, gaps in requirements, missing or non-optimum processes and the content of airworthiness requirements or their interpretation. The issues identified in each of these areas were as follows.

A. Communication and/or timing

1. Four-way communication is only used in crisis situations, often too late.
2. Inconsistent upfront coordination of aircraft and engine requirement.
3. The engine community is not always involved in aircraft rulemaking projects when the engine is impacted, and vice versa.
4. Deferrals in issuance of instructions for continued airworthiness (ICA) after an engine TC may be incompatible with the aircraft manufacturer's needs.

B. Duplication of work

1. There may be unnecessary aircraft compliance verification/testing which has already been adequately carried out at the engine level.
2. Re-investigation of engine compliance during aircraft certification.

C. *Gap in requirements*

1. There may be inadequate verification during engine certification that requires aircraft testing in the installed configuration for aircraft certification.
2. Engine certification requirements may not be optimized to minimize issues arising during aircraft certification (e.g. reliability testing, common-mode effects, auto-shutdown of last engine).

D. *Process related*

1. There is no formal mechanism or process for timely identification, escalation and resolution of engine-aircraft interface issues, particularly when the states of design of the engine and aircraft are different.
2. There is no formal mechanism for engine or aircraft companies to question and escalate decisions to apply aircraft airworthiness requirements and policies (e.g., EWIS) that affect engines.
3. The lack of clear responsibilities, boundaries and best practice guidance leads to late identification of issues, and duplication of certification activities.

E. *Rules/Interpretation*

1. Aircraft and engine interface requirements are not clearly defined.
2. The safety considerations in aircraft and engine requirements sometimes conflict with each other.
3. Inconsistencies exist in aircraft and engine airworthiness requirements, policies, and interpretation.
4. The introduction of new policies, requirements and interpretations at aircraft level can affect the engine certification program (noting that the engine is generally certified in advance of aircraft).
5. Aircraft airworthiness requirements affecting the engine are not reflected in engine airworthiness requirements, and vice versa.
6. Can an aircraft be certified against 14 CFR part 25 and CS-25 if the engine is made non-compliant?

F. *Technical*

1. Engine installation assumptions may be incomplete or inadequate, or not communicated at the right time.
2. Post certification mandatory engine design changes are sometimes needed for aircraft compliance or to address engine non-compliance.

The group devised the questionnaire to understand if the community (both industry and authorities) recognized these issues, or indeed could identify any other issues. The questionnaire also asked for specific examples of problems (e.g., technical topics where the airworthiness requirements or guidance is inconsistent between aircraft and engine specifications) and for suggestions as to how the issues should be addressed. The EACWG received 19 responses; four from aircraft manufacturers, eight from engine manufacturers, two from aircraft authority certification offices, two from engine authority specialists and three from authorities covering both engine and aircraft specialists.

Figure 5-3 to Figure 5-5 include a high-level summary of the questionnaire results for the following question groupings

A=Communication and Timing
B=Duplication of Work
C=Gaps in Requirements
D=Process
E=Rules and Interpretation
F=Technical

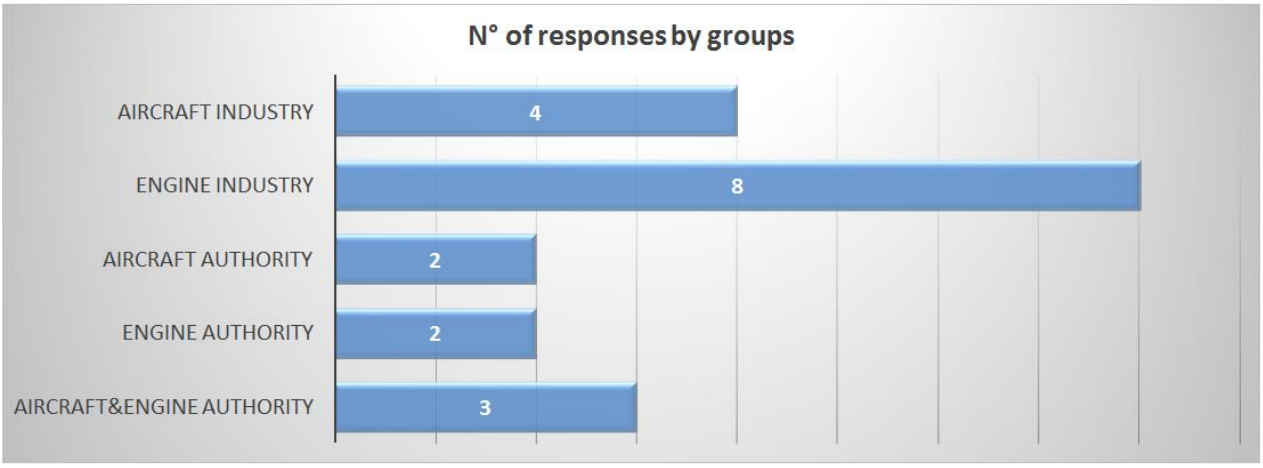

Figure 5-3: Number of responses by groups

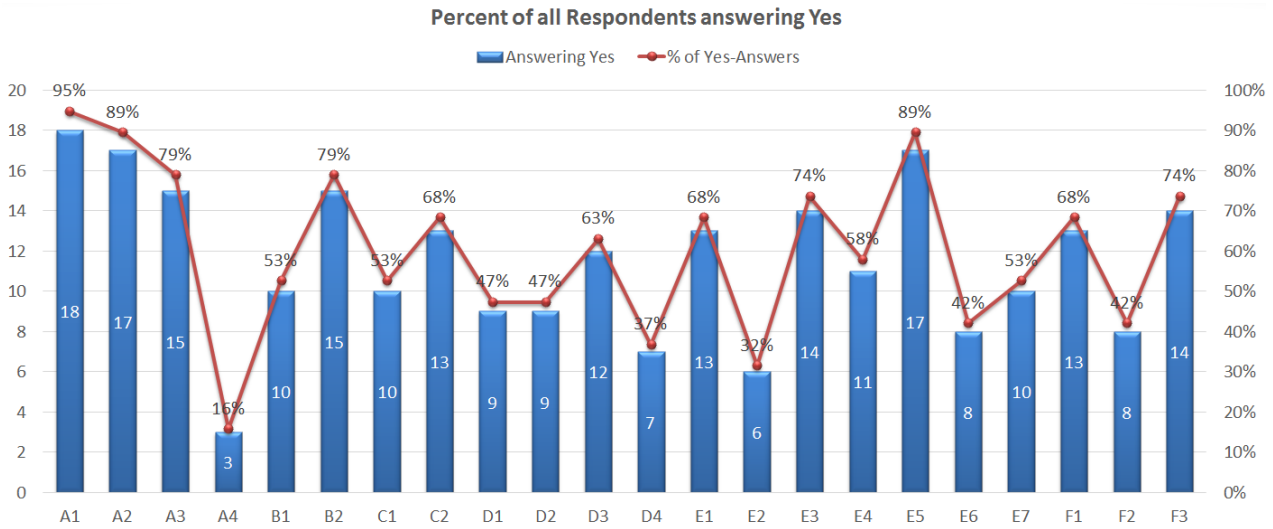

Figure 5-4: Number/Percent of all responses answering "Yes"

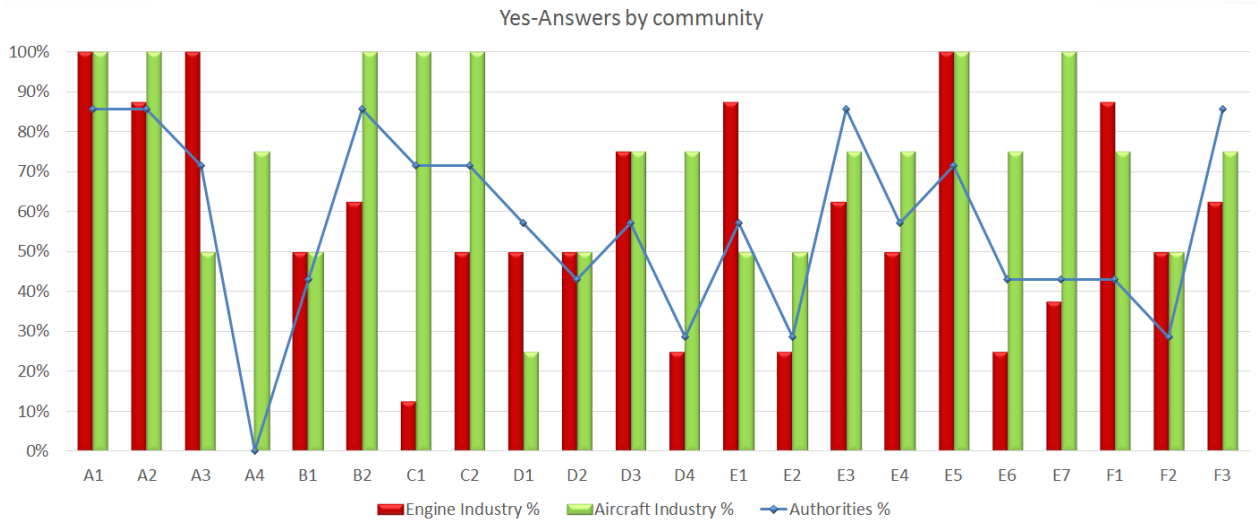

Figure 5-5: Percent of all responses answering "Yes" by groups

The questionnaire responses are given in Appendix D and the key findings are summarized here. Overall the respondents agreed that there is room for improvement in all the areas identified above.

5.2.1 Communication and timing – key output of questionnaire

- All respondents agreed that there have been occasions when interface requirements have not been known early enough in certification programs or have been changed at a late stage.
- There were some interface problem areas raised by a significant number of responders. These include the interpretation of icing rules, auto shut-off of engine protection systems by aircraft systems, several issues relative to fire resistance and fire testing, EWIS, and safety requirements for control systems.
- Several examples were given where engine manufacturers and sometimes the engine specialists in the authorities have been insufficiently involved in changes to airworthiness requirements, guidance or interpretation that ultimately impacted both aircraft and engine designs. Examples give included EWIS, the preference for fire testing with kerosene and requiring adherence to SAE International ARP4754A/ED-79A.
- The timing of the issuance of engine Instructions for Continued Airworthiness (ICAs) has been a cause of concern for the aircraft certification program in some cases, potentially through poor communication and a lack of agreement between aircraft and engine manufacturer on the required timing.

5.2.2 Duplication of work – key output of questionnaire

- It was recognized that aircraft test programs will retest some of the engine's functions – for example some operability tests. However, these tests are typically needed for the aircraft manufacturer to confirm the engine and aircraft interface conditions against which the engine has been certified as well as to confirm the aircraft system characteristics, so they are not wasteful duplication.
- Cases of apparent wasteful duplication were identified. The main examples were associated with either fire test results or the requirement to perform a flight test with updated engine software before the change is cleared on the aircraft even if the change is minor and cannot be checked

during the aircraft test. There were some areas where there is often debate between the parties responsible for the aircraft and the engine (both industry and authorities) on what testing is needed on the uninstalled engine and in flight, for example icing. There were cases where an engine finding has been reinvestigated either because of a change in requirements between the engine and the aircraft certification or because of a view that the engine approach may not be adequate to support aircraft certification. Fire protection and EWIS are two examples that were given.

5.2.3 Gap in requirements – key outputs of the questionnaire

- There are one or two areas where it is recognized that there can be benefits from completing testing that is relevant to engines on the target aircraft. One is rotor lock. The requirements on this topic are quite recent and there is some confusion between parties on the expectations. Another is high-intensity radiated fields (HIRF)/Lightning.
- A number of examples were given where issues occurred on a certified engine during the aircraft certification program, for example an engine failure during a reliability demonstration.
- It was noted that particular care must be taken when an engine previously certified to an earlier requirement set, is used on a new aircraft program, resulting in a significant difference between the engine and the aircraft certification basis.

5.2.4 Process related – key outputs of the questionnaire

- There was agreement that it is harder to resolve interface issues when the states of design of the aircraft and the engine are different.
- There were several examples where engine manufacturers found it difficult to clarify or question decisions taken at aircraft level that impacted engine certification. There have also been occasions when aircraft manufacturers have had difficulty in obtaining clarification on decisions taken at engine level. Industry respondents did not think that there was a clear escalation route for such issues with the authorities.
- Unclear responsibilities and accountabilities between many of the interacting parties were contributors to some of the identified issues.
- Unclear or unusual (for the industry partners) engine and aircraft physical interfaces where parts usually certified under 14 CFR part 25 and CS-25 are cleared under 14 CFR part 33 and CS-E, or vice versa, can cause issues.

5.2.5 Rules/interpretations – key outputs of the questionnaire

- A significant number of areas were identified where there are differences in airworthiness requirements or their interpretations across the engine and aircraft interface which adversely impact the time and resources spent on certification programs. There are further items at aircraft level which have implications for engines that do not appear in the engine airworthiness requirements. The items identified, covering all three categories, were fire test requirements both on the ground and in flight; thrust reverser test requirements; the acceptability of the inhibition of engine protection systems; EWIS application; HIRF requirements; fuel icing; designated fire zones; airworthiness requirements (14 CFR part 33 / CS-E or 14 CFR part 25 / CS-25) that apply to components at the engine and aircraft interface; fire testing pass/fail criteria; flight deck indication of gross fuel contamination; flight deck indication of a fuel filter bypass; fuel venting requirements; burst duct; negative g; fuel leak detection; relight timing interpretations; application of ARP4754A/ED-79A; icing test requirements; acceptable surge definition; thrust control

malfunction; single point failure requirements; extended operations (ETOPS) requirements or maturity requirements.

- There are a few requirements which have a direct link to aircraft system safety where the engine and aircraft requirements may be, or appear to be, incompatible. They include the inhibition of engine protection systems, single point failure requirements, thrust control malfunction and the statement in 14 CFR §33.75 / CS-E510 that an engine's complete loss of thrust on its own should be treated as a minor event.
- It is not unusual for changes to the engine certification basis or the associated means of compliance to be introduced by the authority after they have been agreed. Some changes are due to relevant service experience events while others stem from interface items where there is a lack of clarity.
- It is rare for aircraft manufacturers to request changes to engines that might make them no longer compliant. However there is one topic currently under review. That topic is whether the introduction of aircraft systems that can inhibit engine protection mechanisms results in the engine being non-compliant with 14 CFR part 33 and CS-E.
- There was only one significant example of new technology that impacted the engine and aircraft certification basis causing problems. That was the introduction of a composite fan case and the resulting fire protection method of compliance. Problems associated with the introduction of new technology do not appear to be a significant issue today with respect to certification across the engine and aircraft boundary.

5.2.6 Technical – key outputs of the questionnaire

- It is common for engine and aircraft interface data and requirements from the aircraft manufacturer on the engine manufacturer and vice versa to continue to be developed throughout the engine and aircraft certification programs.

One of the questions in the questionnaire asked respondents to consider changes that might be needed to the engine and aircraft certification process to address new technologies or other business changes in the next 10 to 20 years. Respondents expected engines and aircraft to become more integrated, certification timescales to reduce, and expected that there would be less reliance on testing and more on modelling and analysis. Efficient processes and close working relationships among all parties will be important to meet business needs. It will be even more important for requirements to be consistent across the engine and aircraft interface and among all the authorities (not just the FAA and EASA). Effective mechanisms for managing the development of requirements for novel technologies across the engine and aircraft interface will be required, with the appropriate use of performance based regulations.

5.2.7 Regulatory gap and interdependency - Results

Both the group's brainstorming session and the results of the questionnaire highlighted differences in airworthiness requirements and interpretations at the engine and aircraft levels as a key area for improvement. The team therefore compared the aircraft (14 CFR part 25 and CS-25) and the engine (14 CFR part 33 and CS-E) requirements to identify differences and gaps that might not have been considered by the group or questionnaire responders. This identified 90 interface interdependencies, of which 34 had not been identified previously. Eleven of those resulted in recommendations for action. The comparison is shown in Appendix C.

5.3 Principles for managing the engine and aircraft certification interface

In addition to identifying areas for improvement the questionnaire explored how the responders thought the engine and aircraft certification interface should work. The output of this part of the questionnaire is summarised in Appendix D (pages 82-86).

Based on these results, supported by group discussion, the group concluded that the engine TC is an essential part of the type design certification process. The following regulatory objectives should be pursued:

- The engine TC process shall deliver a safe product.
- To the maximum extent possible, all engine related activities shall be performed during engine certification.
- Those activities shall not be further investigated during aircraft certification.
- The regulatory system should not be sensitive to the engine/aircraft interfaces and boundaries.
- The regulatory system between engine and aircraft certification should be consistent, so that if the engine certification requirements are met, and the interface conditions are fully known, it should be possible to meet the aircraft certification requirements without any additional test demonstration and/or change to the engine design. Note: Interface conditions cover all the interdependencies, for example, power requirements at specific conditions, and not just physical interfaces.

To support these principles it was agreed that:

- Aircraft certification requirements may apply to engines as a relevant aircraft system.
- The engine certification requirements should include all engine related activities so that it is straightforward for an engine manufacturer to establish the necessary activities to support the overall aircraft (e.g., aircraft and engine) certification activity. Hence where aircraft certification requirements are applicable to engines they should also appear in the engine certification specifications. In some cases this may be by direct reference to aircraft requirements if that is the most effective way of defining the requirements.
- Engine and aircraft airworthiness requirements should be consistent. Requirements on the same topic may be different because of the nature of the product and where this is the case a clear statement should be made that the engine and aircraft requirements are equivalent so that if the engine requirement is met, no further work will be required at engine level on that topic to meet aircraft requirements.
- Rulemaking and guidance making activity that is relevant to both aircraft and engines must consider both sets of requirements and guidance from the start, with any changes being introduced to both at the same time. It should be clear when a change is made to similar or related airworthiness requirements for one product that there are no similar requirement changes necessary for other products and why existing requirements are adequate.
- Formal mechanisms and processes should be in place to facilitate communication between all parties including engine and aircraft manufacturers, authority aircraft specialists and authority engine specialists, recognising that the authorities for engine and aircraft certification may be from different states of design. These mechanisms and processes must address the activities conducted during certification programs including resolving project specific problems, addressing generic

issues across the engine and aircraft boundary and developing airworthiness requirements and guidance.

- Another key aspect to support these principles is that aircraft and engine manufacturers are responsible and accountable for showing compliance with all applicable airworthiness standards of 14 CFR part 25 / CS-25 and 14 CFR part 33 / CS-E, respectively. For aircraft manufacturers, this responsibility includes providing evidence that the engine and its installation meet all applicable 14 CFR part 25 / CS-25 standards. It is clear that timely and frequent communication between the aircraft and engine manufacturer is critical to preclude potential integration-related issues. The group concentrated on authority coordination and regulatory requirements, but successful aircraft and engine certification is impossible without early, frequent and detailed communication and coordination of requirements between the engine and airplane manufacturers. Aircraft and engine manufacturers should continue working together to minimize interface problems, and raise regulatory or guidance issues to airworthiness authorities as they arise.

6 Recommendations

Following the analysis of the data from the questionnaire and the regulatory gap and interdependency analysis, and having established the principles above, the group recommends that a number of actions should be taken. These actions are divided into those most directly related to how a certification program is managed, those involving the processes involved, and those that relate to specific technical requirements that have been identified as causing inefficiencies in certification programs today. There are also a few recommendations on topics that have arisen that are beyond the scope of this group, but which may be appropriate for further work. These actions will help to bring the system for engine and aircraft certification in line with the objectives and intent identified above, and improve the efficiency and effectiveness of certification programs. The recommendations are restricted to certification and regulatory activities conducted by the authorities or by the authorities and industry. The group has not made any recommendations that relate to activities between aircraft and engine manufacturers, leaving it to the manufacturers themselves to use the group findings to address any areas for improvements.

The recommendations are listed below. Additional details of the recommendations, with an assessment of their potential benefits, the scale of resource needed to implement them, and their priorities, are given in Appendix E and Figure 6-1 to Figure 6-4 below.

In addressing the recommendations below, great care should be taken to involve all relevant stakeholders, from both the authority and industry (engine and aircraft) sides.

6.1 Conducting a certification program

Note: The highest priority recommendations are indicated in blue.

The EACWG recommends that EASA and/or the FAA (as appropriate) should carry out the following actions:

R 1.1	At the request of the applicant, conduct multiparty project reviews with engine/aircraft applicants and regulators early in a certification effort to list, detect, and resolve regulatory gaps, overlaps, and interdependencies, and repeat as necessary.

R 1.2	Develop authority internal processes to require aircraft and engine regulators to cross-communicate and resolve interface issues at the start of a program or immediately after they arise. Note: R.1.1 and R1.2 would typically only involve the primary certificating authorities of both products, but might be extended to more parties.
R 1.3	Develop an efficient process for engine/aircraft manufacturers to communicate conflicting requirements to the engine and aircraft authorities and to escalate, and resolve them.
R 1.4	Develop internal authority training and processes to drive cultural/behavioural change to ensure seamless integration and implementation of aircraft and engine regulations and guidance.

6.2 Understanding and developing the regulatory requirements

R 2.1	Develop and document an authority approach specifying the ground rules for developing regulations and guidance at the engine-aircraft interface.
R 2.2	Review engine interface requirements at the 14 CFR part 33, CS-E, 14 CFR part 25 and CS-25 levels for potential changes to decrease redundancy/gaps (reference Appendix C).
R 2.3	Review the 14 CFR part 33 and 14 CFR part 25 policies and the CS-E and CS-25 certification memoranda for potential changes to decrease redundancy/gaps.
R 2.4	Maintain an up to date regulatory and interpretations difference list between engine (14 CFR part 33 and CS-E) and aircraft (14 CFR part 25 and CS-25) requirements that is easily accessible to all stakeholders.
R 2.5	Create, maintain and publish a list on how aircraft requirements are met at engine level so that it can be easily reviewed by stakeholders to aid certification programs.
R 2.6	Revise relevant safety analysis policies to highlight the differences in engine and aircraft certification methodologies, and provide rationale for those differences.
R 2.7	Establish a forum and process for engine and aircraft airworthiness authorities and industry to review conflicts and gaps between engine (14 CFR part 33 and CS-E) and aircraft (14 CFR part 25 and CS-25) regulations to eliminate them and to proactively review regulatory change opportunities.
R 2.8	Publish policies/Certification memoranda or rule updates to formalize the regulatory approach to topics covered by generic issue papers and CRIs (e.g., issued on every current program) and make the required certification standard clearer.

6.3 Understanding if the engine/aircraft certification interface is working effectively

R 3.1	Monitor occurrence of interface issues during certification projects (e.g., number, frequency and severity), review and recommend changes to processes, regulations and/or policies if appropriate.

6.4 Address specific rule and policy gaps

R 4.1	Review 14 CFR part 33 and CS-E to determine how they support the functional and reliability flight test requirement of 14 CFR 21.35(f)/ CS 21.A.35(f). If needed, propose amendments to the relevant requirements.
R 4.2	Publish policy for 14 CFR part 33 and CS-E to address rapid restart/high power fuel cuts and quick windmill relight in the 14 CFR part 33 and CS-E guidance and/or complete rulemaking as needed.
R 4.3	Revise the 14 CFR part 33, CS-E, 14 CFR part 25 and CS-25 policies to ensure that rotor blade fragments that lie outside the compressor and turbine rotor case, as established during the engine certification, are given due considerations during aircraft certification, when appropriate.

R 4.4	Publish AC 25.1535-X to address ETOPS policy on acceptable methods of compliance, including type design changes and when flight testing is required. Address cases where § 25.1535 is part of the aircraft certification basis but §33.201 is not in the installed engine certification basis. Coordinate 14 CFR part 33 with 14 CFR part 25 and revise 14 CFR part 33 policy as needed. EASA should consider publishing harmonized guidance.
R 4.5	Address if and when aircraft systems should be able to inhibit the operation of engine systems for preventing hazardous engine failure in the event of an engine loss of load. Determine what regulatory or policy/guidance changes would be needed to implement the recommendations and initiate the regulatory change process, taking note of discussions already held.
R 4.6	Define a harmonized set of requirements for fire protection and the verification of fire protection requirements. Provide recommendations within 6 months to address the current issues, and make recommendations in the longer term that, when implemented, would give a fully appropriate, consistent and implementable set of regulations and guidance on fire protection.
R 4.7	Establish whether compliance with existing 14 CFR part 33 and CS-E regulations meets all 14 CFR part 25 and CS-25 EWIS requirements. If it does, formally document how this is achieved; if not, provide guidance at the engine and aircraft level on meeting EWIS requirements and secondly propose changes to 14 CFR part 33 and CS-E that would meet the 14 CFR part 25 and CS-25 EWIS requirements. Initiate regulatory change processes if needed.
R 4.8	Update AC 20-18B (Qualification Testing of Turbojet and Turbofan Engine Thrust Reversers) to clarify that aircraft regulatory requirements must still be met when the thrust reverser is included as part of the engine type certificate. EASA to produce new EASA thrust reverser AMC to cover this issue.
R 4.9	Consider expanding the EASA guidance in AMC E 10 (b) or AMC E 890 in line with AC 20-18B (Qualification Testing of Turbojet and Turbofan Engine Thrust Reversers).
R 4.10	Clarify the requirements at engine level – expected to be associated with the scope of engine control system – when an aircraft certification program is using a process from a non-regulatory document, such as ARP4754A/ED-79A, to show compliance with an aircraft regulation, such as §25.1309. Engine and aircraft policies should be coordinated to allow the normal sequence of certification execution, so that the engine certification (before aircraft certification) is not revisited later and does not impose additional requirements on the engine control system via the aircraft certification basis.
R 4.11	Review the icing requirements to see if improvements in guidance or application can be made to streamline the process across the interface. Initiate the regulatory change process to address any required improvement.
R 4.12	Resolve the discrepancy between certification and operational snow requirements.
R 4.13	Review the 14 CFR part 33, CS-E, 14 CFR part 25 and CS-25 policies on flight deck indications/instrumentation to ensure they are consistent and up to date. Address any issues found. Replace the 14 CFR part 25 repetitive issue paper on fuel system contamination indication with a published policy.

6.5 Recommendations and observations beyond the scope of the task group

R 5.1	Review the operating regulations (e.g. 14 CFR part 121) vs 14 CFR part 33 / CS-E and 14 CFR part 25 / CS-25 to determine whether any other discrepancies exist between the certification and the operational regulations.
R 5.2	Consider the need for a similar activity to be conducted on other product types (propellers, General Aviation aircraft, rotorcraft) and APUs in a follow-on activity.
R 5.3	Coordinate with the Environmental Protection Agency (EPA) / International Civil Aviation Organization (ICAO) on how best to address fuel venting requirements/interpretation as

a follow-on activity. Note: the potential outcome is a rule change to 14 CPR § 34.11 in recognition of a change in technology.

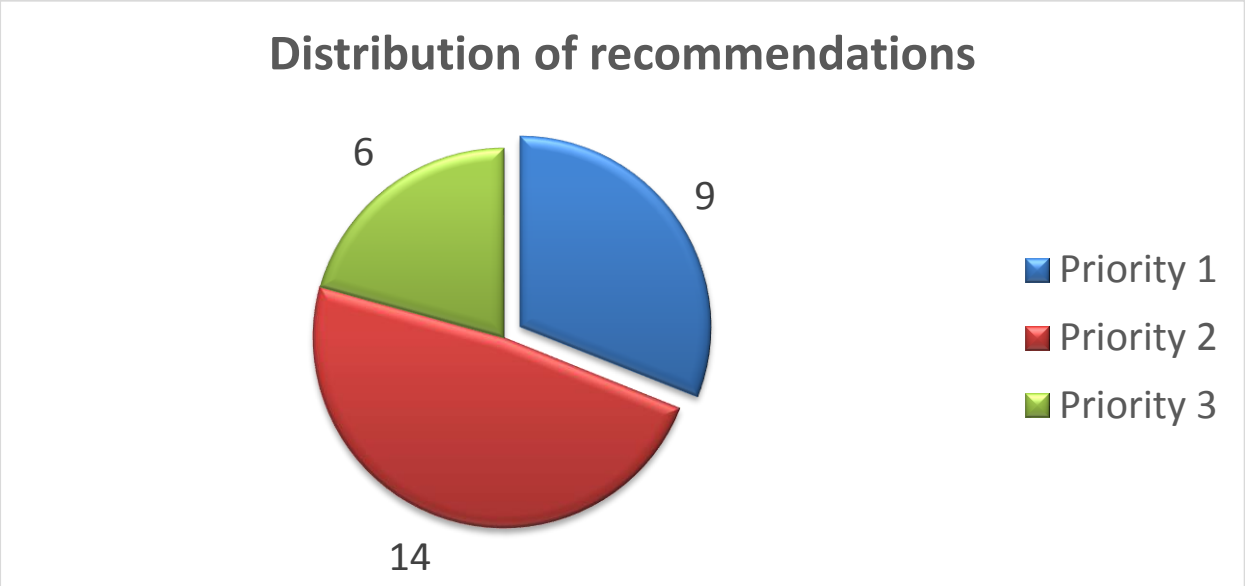

Figure 6-1: Distribution of Recommendations by Priority

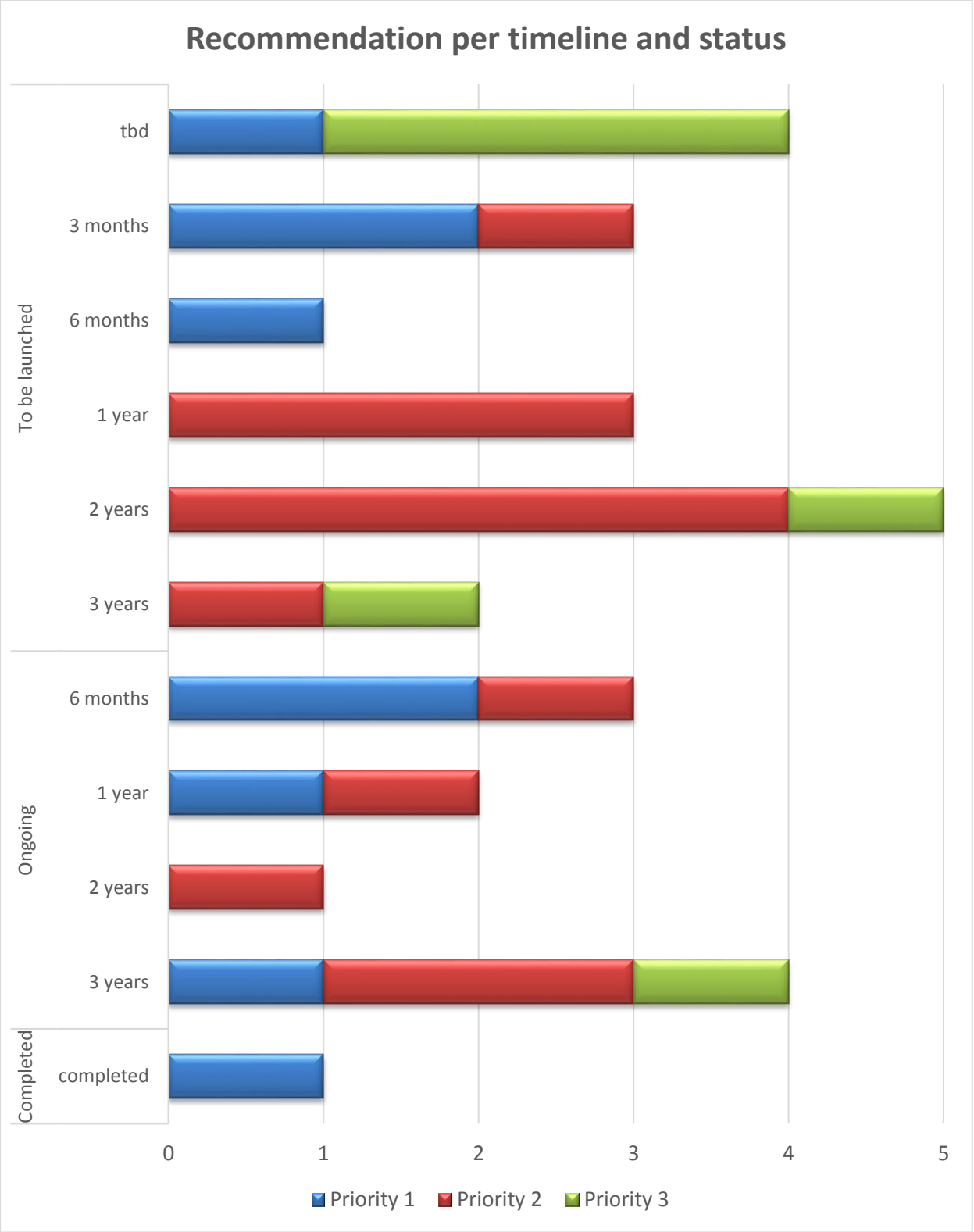

Figure 6-2: Recommendations per Timeline and Status

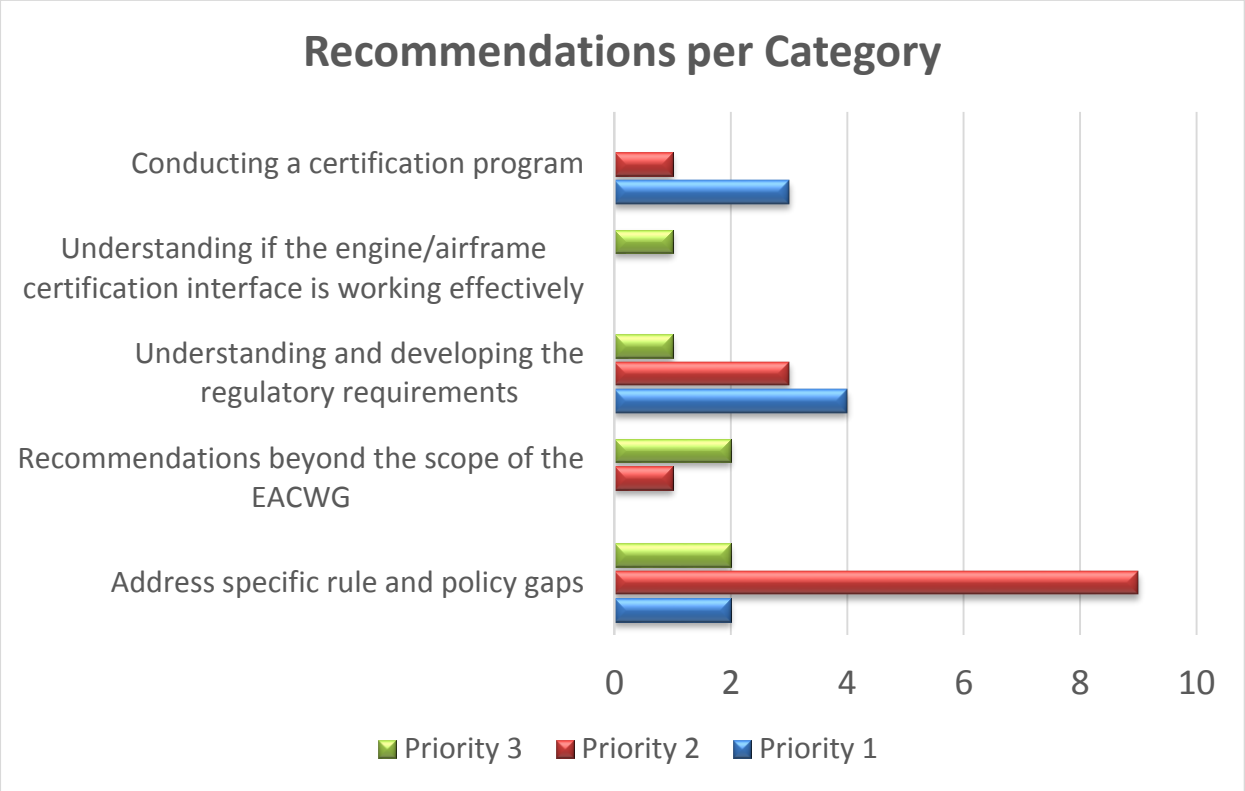

Figure 6-3: Recommendations per Category

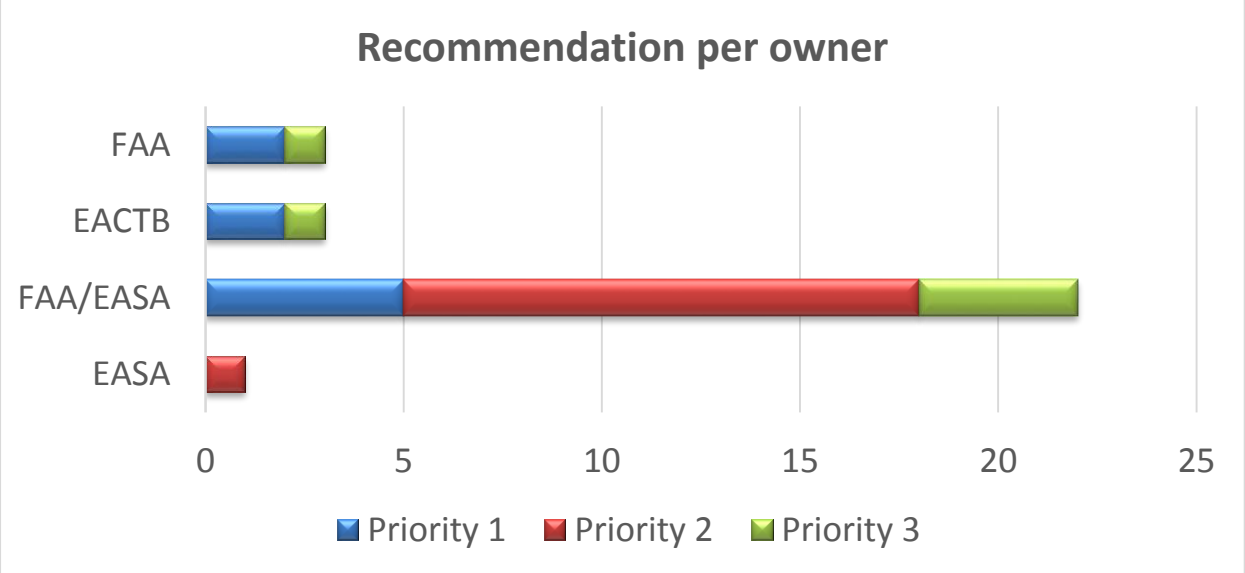

Figure 6-4: Recommendations per Owner

7 Group Consensus

The group was able to come to consensus on the nature of the existing issues, and the recommendations proposed to resolve them. When the group was polled, no minority opinions were expressed.

8 Implementation Plan

Taking into account the recommendations listed in Section 7, an implementation plan is proposed below.

The group is proposing to create a new standing group to monitor interface issues. Various actions are placed on FAA and EASA, including drafting several policies/certification memoranda, as well as amending or upgrading internal processes to improve coordination between the engine and aircraft certification processes.

The noted completion dates are based on starting the activity the date the report is approved by FAA and EASA management. The exact resources required to comply with the recommendations cannot be determined at this stage. It might not be feasible to launch all actions simultaneously; so there may be need for further prioritization.

While these recommendations do not indicate that Industry is responsible, the authorities may request assistance from Aerospace Industries Association (AIA) and AeroSpace and Defence Industries Association (ASD) in the development of various rule, policy, and guidance documents resulting from these recommendations, as appropriate.

Note: in section 9.1, the recommendation text has been summarized and edited to improve readability. For the exact text of the recommendations, reference shall be made to section 6.

8.1 FAA and EASA will launch internal actions to:

8.1.1 Provide guidelines to current and future certification teams to support, upon applicant request, 4-way meetings (recommendation 1.1).

- Action to be completed within 3 months. Letter in 3 months and follow-on 'formal' document in 2 years.

8.1.2 Develop processes to improve internal authority coordination (recommendation 1.2). The actual vehicle might differ between the two authorities; FAA might issue an order, EASA might issue a work instruction or develop the certification handbook, however it is expected that coordination will take place on the actual content.

- Action to be completed within 3 months. Letter in 3 months and follow-on 'formal' document in 2 years.

8.1.3 Develop training material allowing better coordination and mutual understanding between aircraft and engine certification staff. (recommendation 1.4). This may also include other actions, depending upon each authority and its context, including for instance staff exchanges.

- Action to be completed within 3 years.

8.1.4 Ensure that the rulemaking process allows regulatory and policy development that improves and maintains full consistency and continuity between engine and aircraft certifications (recommendation 2.1).

- Action to be completed within 3 months. Letter in 3 months and follow-on 'formal' document in 2 years.

8.2 FAA and EASA will review current policies and establish lists in order to help all parties identify interfaces. These lists will be published to support certification projects and be used for policy/regulatory activities, in order to:

8.2.1 Review 14 CFR part 33 and 14 CFR part 25 policies and CS-E and CS-25 certification memoranda for potential changes to decrease redundancy/gaps (recommendation 2.3).

- Action to be completed within 2 years.

8.2.2 Check engine interface requirements at the engine (14 CFR part 33 and CS-E) and aicraft (14 CFR part 25 and CS-25) levels for potential changes to decrease redundancy/gaps (recommendation 2.2). This was completed as part of the EACWG activity.

- Action completed (reference Appendix C)

8.2.3 Maintain an up-to-date regulatory and interpretations difference list between engine (14 CFR part 33 and CS-E) and aircraft (14 CFR part 25 and CS-25) requirements (recommendation 2.4).

- Action to be completed within one year. The list will be subsequently maintained by the Engine Aircraft Certification Tracking Board (EACTB).

8.2.4 Prepare a list that describes how aircraft requirements are met at engine level so that it can be easily reviewed by stakeholders to aid certification programs (recommendation 2.5).

- Action to be completed within 3 years. The list will be subsequently maintained by the EACTB.

8.3 FAA and EASA will undertake policy development on the topics listed below.

Policies can be developed either jointly, or after agreement by one of the authorities taking the lead but maintaining coordination with the other.

The authorities may seek early industry feedback on draft policy, for example through AIA and ASD. If significant issues are identified during the policy drafting or commenting period, the FAA and EASA should consider setting up a working group with industry participation to facilitate resolution of the issues.

The FAA and EASA will issue policies and certification memoranda or rule updates to formalize the regulatory approach to topics covered by generic issue papers and CRIs (recommendation 2.8).

- FAA internal process to be completed within 6 months. Individual policies to be issued consistent with the new process.

- EASA to incorporate changes into certification specifications and acceptable means of compliance using the existing regular updates process.

It is not realistic to expect all policies/certification memoranda to be developed simultaneously. The FAA and EASA should review their work plan and define the detailed implementation plan accordingly. The subjects to be addressed are as follows:

- Prepare a list of fire protection related recurrent open issues, which will be used to support projects, and task fire safety conference's ad-hoc working group, or potential new working group (recommendation 4.6).
- The FAA should publish the draft AC 25.1535-X related to ETOPS, which will prompt the establishment of corresponding Extended Diversion Time Operations policies at EASA and possibly changes to 14 CFR part 33 and CS-E (recommendation 4.4).
- Address if and when aircraft systems should be able to inhibit the operation of engine systems for preventing hazardous engine failure in the event of an engine loss of load (recommendation 4.5).
- EWIS compliance for engines; EASA is developing a Certification Memorandum, and the draft CM will be shared with the FAA and industry (recommendation 4.7).
- The applicability of ARP 4754A/ED 79A to engine control (recommendation 4.10).
- Rapid restart/high power fuel cuts and quick windmill relight in 14 CFR part 33 and CS-E guidance and/or complete rulemaking as needed (recommendation 4.2).
- Flight deck indications/instrumentation, with a focus on fuel system contamination (recommendation 4.13).
- EASA to consider expanding the guidance in AMC E 10 (b) or AMC E 890 in line with AC 20-18B pertaining to Qualification Testing of Turbojet and Turbofan Engine Thrust Reversers (recommendation 4.9).
- The FAA to update AC 20-18B to clarify that aircraft regulatory requirements must still be met when the thrust reverser is included as part of the engine TC. EASA to produce new thrust reverser AMC to cover this issue (recommendation 4.8).
- Review the snow requirements policy to align the design requirement with the FAA operational requirements (recommendation 4.12).

The FAA, EASA and industry (AIA/ASD) will set up working groups to tackle more complex issues, as needed.

8.4 The FAA and EASA will address the following topics.

- Revision of the relevant safety analysis policies to highlight the differences between the engine and aircraft certification methodologies (recommendation 2.6).
- How 14 CFR part 33 and CS-E support the functional and reliability flight test requirement 14 CFR § 21.35(f) and Part 21.A.35(f) (recommendation 4.1).
- How to ensure continuity between the engine certification fan blade out test and the aircraft certification in case fan blade fragments are not axially contained (recommendation 4.3).
- Icing requirements, to streamline the process across the engine and aircraft interface (recommendation 4.11).

8.5 The FAA, EASA (plus eventually other authorities) and industry will create a standing group to discuss engine and aircraft certification issues.

The Engine Aircraft Certification Tracking Board (EACTB) shall meet yearly. In order to minimize the burden, it is proposed to organize a one day meeting each year coincident with one of the Certification Authorities for Propulsion (CAPP) meetings, outside of the CAPP remit. The EACTB will work closely with the CAPP and the Certification Authorities for Transport Airplane (CATA).

The EACTB should be co-chaired by the FAA and EASA and have a membership similar to the EACWG with representatives from authorities and industry, both from both engine and aircraft sides. The EACTB should expand to include other authorities, such as ANAC and TCCA, when appropriate. The EACTB will be tasked with tracking the implementation of the EACWG recommendations, as well as monitoring and reporting any new issue identified either during or outside of projects, for instance associated with new technologies. The report will be provided to both the CAPP and the CATA.

Setting up the EACTB will provide a forum which can address recommendations 1.3, 2.7 and 3.1. The meetings will also be used to launch discussions on some specific topics listed as recommendations.

- Action to be launched immediately, with the objective to have the first meeting with the CAPP planned in February 2018 (alternative earlier date might be considered).

8.6 The FAA and EASA will draft a common letter raising issues associated with fuel venting requirements, to be addressed to the respective focal (recommendation 5.3).

- Action to be completed within one year.

8.7 The group recommends that FAA and EASA management consider the need for a review of the consistency between design and operating requirements, and to eventually extend the review to other product types (propellers, General Aviation aircraft, and rotorcraft) and APUs in a separate activity (recommendations 5.1 and 5.2).

The timeline of proposed actions can be summarized as follows.

The completion dates in Table 8.1 below are based on starting the activity the date the report is approved by FAA and EASA management. Since the exact resources required cannot be determined at this stage, the FAA and EASA may need to further prioritize.

Recommendation	Completion Date	Responsible
R.1.1	3 months [1]	FAA/EASA
R.1.2	3 months [1]	FAA/EASA
R.1.3	tbd [2]	EACTB [3]
R.1.4	3 years	FAA/EASA
R.2.1	3 months [1]	FAA/EASA
R.2.2	completed	FAA/EASA
R.2.3	2 years	FAA/EASA
R.2.4	1 year	FAA/EASA
R.2.5	3 years	FAA/EASA
R.2.6	2 years	FAA/EASA
R.2.7	6 months [2]	EACTB [3]
R.2.8	6 months	FAA
R.3.1	tbd [2]	EACTB [3]
R.4.1	2 years	FAA/EASA
R.4.2	1 year	FAA / EASA
R.4.3	1 year	FAA/EASA
R.4.4	6 months	FAA
R.4.5	6 months	FAA/EASA
R.4.6	3 years	FAA/EASA
R.4.7	1 year	FAA/EASA
R.4.8	3 years	FAA
R.4.9	2 years	EASA
R.4.10	2 years	FAA/EASA
R.4.11	3 years	FAA/EASA
R.4.12	3 years	FAA/EASA
R.4.13	2 years	FAA/EASA
R.5.1	tbd	FAA/EASA
R.5.2	tbd	FAA/EASA
R.5.3	1 year	FAA/EASA

Table 8-1: Recommendation Timeline

Table 8.1 Notes:

1. Follow-on issuance of 'formal' document not included in completion date.
2. Kick-off first EACTB meeting
3. EACTB membership includes FAA, EASA, and Industry

9 Conclusion and next steps

The group established that the current system does deliver safe products. It also unanimously concluded that the current general principle of having two independent TCs for the engine and for the aircraft shall be maintained.

The group did not recommend changing airplane and engine manufacturer responsibilities or accountabilities for showing compliance with the applicable airworthiness standards of 14 CFR part 25 / CS-25 and 14 CFR part 33 / CS-E, respectively.

There is however room for improvement in processes and regulatory matters, and to that effect the EACWG recommends 29 actions. The recommendations are aimed at making it easier to maintain and improve the current safety level and to improve the efficiency of the engine and aircraft certification processes. Most of the recommendations are focussed on the engine and aircraft interface.

Addressing all the recommendations will require resources however there will be efficiency benefits, along with other associated benefits including some for safety. The group recognises that resources will be needed to address the recommendations but it is confident that the time and effort will be amply compensated by the efficiency gain in certification programs and the ability to maintain and improve safety by allowing all parties to focus on the key items

The EACWG considers that its activity was useful and would recommend considering similar reviews of other product categories or TSO/ETSOs should be considered, including propellers, APUs, rotorcraft and General Aviation aircraft.

10 Appendices

Appendix A - P. Ky letter and M. Gilligan response
Appendix B - Working Group membership and meetings
Appendix C - Table of engine installation-related regulations
Appendix D - Questionnaire and results
Appendix E - Full list of recommendations
Appendix F - Detailed survey responses

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List of Acronyms

AIA	Aerospace Industries Association of US
ANAC	Agencia Nacional de Aviacao Civil
APU	Auxiliary Power Unit
ARP	Aerospace Recommended Practice
ASD	AeroSpace and Defence Industries Association of Europe
CAPP	Certification Authorities for Propulsion
CATA	Certification Authorities for Transport Airplane
CRI	Certification Review Item
DOA	Design Organization Approval
EACTB	Engine Aircraft Certification Tracking Board
EACWG	Engine Aircraft Certification Working Group

EASA	European Aviation Safety Agency
EDTO	Extended Diversion time Operations
EPA	Environmental Protection Agency
ETOPS	Extended Range Operations with Two-Engine Aircraft
ETSO	European Technical Standard Order
EWIS	Electrical Wiring Interconnection Systems
FAA	Federal Aviation Administration
HIRF	high-intensity radiated fields
ICA	Instruction for Continued Airworthiness
ICAO	International Civil Aviation Organization
SAE	Society of Automotive Engineers
STC	Supplemental Type Certificate
TC	Type Certificate
TCCA	Transport Canada Civil Aviation
TSO	Technical Standard Order

Appendix A - P. Ky letter and M. Gilligan response

Patrick KY
Executive Director

PKY/ASE (ED.0.1) D (2016) 50573
Cologne,
3 FEB. 2016

Ms. Margaret Gilligan
Federal Aviation Administration
Associate Administrator for Aviation Safety
800 Independence Avenue, SW
Washington, DC 20591
USA

Subject: Cyber security and Engine Certification Review Group

Dear Ms. Gilligan, Dear Peggy

Subsequent to our phone conversation on the 6th of January I would like to come back to you on the specific subjects of cybersecurity and engine certification.

Cyber security

Cyber security is a global issue, which cannot be addressed successfully by one region or one stakeholder alone. It requires that all civil aviation stakeholders are acting in concert. Since projects like the A380 and B787, EASA and FAA are harmonizing Special Conditions on cybersecurity. Close cooperation is maintained during certification and validation of products. Today, the FAA and EASA are both observers in the ASISP ARAC and the current development is going well toward a single common rule, covering large aircraft, general aviation and rotorcraft.

RTCA and Eurocae have set up committees which jointly developed standards material with respect to the consideration of cyber threats primarily during the type certification process and continuing airworthiness. There have been differences not only of opinion but also schedule, preventing a joint publication for methods and means of compliance. However, members of both committees are in the process of resolving the differences between their respective approaches.

During its meeting in December 2015, the EASA Management Board has endorsed an Aviation Cybersecurity Roadmap – responding to an EU Commission request – that lays down key strategic actions at European level for a better mitigation of cybersecurity risks. EASA is now in the process of implementing this roadmap. Two key elements are certainly of mutual interest to both our organizations: the setting up of an Aviation Computer Emergency Response Team (AV CERT), which is intended to foster the exchange of information about vulnerabilities and cyber incidents, and the development of a regulatory concept for the inclusion of cybersecurity. Both subjects are also of high interest to the civil aviation industry. It would be thus beneficial to both of our organizations to closely collaborate on all relevant levels.

I would very much welcome the opportunity for our organisations to exchange on possible ways of cooperation and to formalise the involvement on both the AV-CERT and regulatory aspects. The point

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of contact from my team will be Jean-Paul Moreaux (jean-paul.moreaux@easa.europa.eu). I hope this proposed way forward finds your agreement, and I would be most grateful if you could appoint a point of contact for the AV-CERT on your side as well.

Future ways of engine certification

The EASA experience on several recent certification programs has highlighted the fact the current approach of having two totally independent certification processes for engine and large transport aeroplane might have some limitations. Designing, certifying and producing turbine engines or large transport aeroplanes are indeed two very different businesses, requiring very different skills and expertise; however in the end both are integrated onto the same final product.

While there is a likely advantage in having an engine TC first, as it addresses the basic safety of the engine, there are at the same time some limitations. And due to the fact that turbine engines are more and more tailored for a specific aircraft type and due to the increased overall complexity, this might not be properly reflected in the current EASA or FAA regulatory systems and might have caused some issues.

During recent aircraft certification programmes some issues were raised related to the engine, despite the fact that it was previously approved and held its own TC. Such issues have included some technical matters showing possible inconsistencies between engine and aircraft certification requirements, resulting in burdensome certifications processes due to redundant or even conflicting aircraft and engine requirements, e.g. in the areas of Control system integration and the application of ARP4754 at engine level, Fire protection and Icing.

Also more procedural matters were highlighted such as Communication between engine and aircraft TC holders and the associated authority staff, Lack of mutual understanding by aircraft and engine manufacturers of their respective certification requirements and Lack of synchronisation of both certification processes.

The issues experienced lead to the question whether maintaining two separate engine and aircraft Type Certification processes is the optimal solution, from either economical and safety perspectives.

For this reasons, I propose to launch an initiative to critically look at engine certification practices and openly and innovatively look at future ways for improvement. Preferably co-chaired by EASA and FAA. In the attachment you will find our first ideas of such a working group for further discussion with your team. If you agree with the general principle of starting this initiative, both Dorenda Baker and Trevor Woods could further explore and define the Terms of Reference and the mutual participants.

I am looking forward to strengthen our cooperation both in the field of cyber security and engine certification.

Yours sincerely, I look forward to meeting you soon!

Patrick KY

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ATTACHMENT

Future ways of engine certification - Proposal for working group

An ad-hoc working group should be set up, co-chaired by both bilateral partners FAA and EASA, supported by representatives from engine and aircraft type certificate holders from Europe and the USA. The purpose of this working group would be to develop recommendations on the best way(s) to perform engine and aircraft certifications, in order to ensure safety while making the most efficient use of resources from regulatory bodies and industry.

The group should provide an in-depth review of the current practices and identify what is working well and what issues can be improved. Within one year after the kick-off meeting the group should come with proposals on how to better streamline and improve the way engine and aircraft certifications interact. The scope of the working group shall be at least initially focusing on Part 25 engine integration issues.

Participation should be balanced between Europe and the United States. In order to keep the group manageable, it is proposed to envisage a limited membership at this stage.
For the European side, the following participants are suggested:

- EASA, including representatives from both the Propulsion and Large Aeroplanes departments,
- 2 Engine manufacturers, Rolls-Royce and SAFRAN/SNECMA,
- 1 Aircraft manufacturer, Airbus.

The FAA is invited to organise the US participation in a similar composition.

The kick-off meeting should be held in April 2016 and EASA offers to host this first meeting in Cologne. Subsequent activity would involve two other face-to-face meetings, as well as any required telephone or video conferences. The goal would be to present the outcome of the discussion to the International EASA/FAA conference in June 2017.

The working group should review all options available. This might include (list not exhaustive, to be further developed by the working group):

1. Change nothing.
2. Cultural, organisational and/or procedural changes within the authorities, to better align the engine and aircraft certification processes.
3. Rulemaking effort to align the Part 25 and Part 33 / CS-E, including means of compliance and policies.
4. Basic regulation / Part 21 changes to ensure an aircraft and its engine are seen as a whole, from a certification standpoint, as they are in the actual life.
    a. To clearly subordinate the engine to the aircraft (e.g., turn the engine TC into an ETSO, or upgrade the aircraft to a 'final product' having a 'super TC'), or
    b. Introduce a two (or more) staged TC process for the engine, one covering the basic/core engine, the other dressing interface areas.

An agency of the European Union

TE.GEN.00104-002

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Figure 10-1: EASA letter to FAA

U.S. Department
of Transportation
**Federal Aviation
Administration**

800 Independence Avenue SW.
Washington, DC 20591
U.S.A.

Mr. Patrick Ky
Executive Director
European Aviation Safety Agency (EASA)
Postfach 10 12 53
50452 Cologne, Germany

Dear Mr. Ky:

Thank you for your February 3 letter regarding cybersecurity and engine certification. This response addresses your proposal for an Engine Certification Review Group.

You state the purpose of this group would be to conduct an in-depth review of our current certification practices and processes, and to develop recommendations by June 2017 on changes that would streamline and improve the overall process. The scope of the working group would focus initially on engines installed in transport category aircraft.

We agree that the current approach of two independent certification processes for engines and aircraft has its challenges due to the highly integrated nature of propulsion systems that exist today. We fully support your proposal to launch this group, and would like to co-chair the group with EASA as you suggest.

We would also like to request that you invite representatives from Transport Canada Civil Aviation and Agência Nacional de Aviação Civil, and their industry, to join this group under the Certification Management Team governance framework due to the potential global industry impact.

Mr. Robert Ganley, Manager, Engine & Propeller Directorate Standards Staff, Aircraft Certification Service, will be the FAA co-chair. Mr. Ganley has been involved in the Certification Authorities for Propulsion Projects meetings for several years. We have already identified part 33 and part 25 subject matter experts to support this group, and are in the process of finalizing U.S. engine and aircraft industry participation from General Electric, Pratt & Whitney, and Boeing. Mr. Ganley has already initiated contact with Mr. Markus Goernemann regarding this activity, and they are discussing potential dates in the April-May 2016 timeframe for the kick-off meeting in Cologne.

Thank you for the opportunity to work collaboratively with EASA on this activity. If I can provide further information or assistance, please do not hesitate to contact me.

Sincerely,

Margaret Gilligan
Associate Administrator for
Aviation Safety

Figure 10-2: FAA response to EASA letter

Appendix B - Working Group membership and meetings held

Organisation	Name
EASA	Laurent Gruz
	Markus Goernemann
	Angus Abrams
	Remi Deletain
	Pascal Lair
FAA	Bob Ganley
	Alan Strom
	Doug Bryant
Airbus	Johann Hervault
	Olivier Lacomme
	Yves Regis
Boeing	Nasser Vaziri
	John Ostic
General Electric	Tony Murphy
	Douglas Beneteau
Pratt & Whitney	Robert Benjamin
Rolls-Royce	Belinda Swain
Safran Aircraft Engines	Dominique Bouvier

Table 10-1: Members of Working Group

The group held a total of four meetings and 12 telecons to complete the assigned task as follows:

Date	**Kind of Meeting**
May 20-21, 2016	Meeting #1 (Cologne, Germany)
June 7, 2016	Telecon #1
July 5, 2016	Telecon #2
August 2, 2016	Telecon #3
September 5, 2016	Telecon #4
October 4, 2016	Telecon #5
November 1, 2016	Telecon #6
November 8-9 2016	Meeting #2 (Burlington, MA)
December 6, 2016	Telecon #7
January 10, 2017	Telecon #8
February 7, 2017	Telecon #9
February 21-22, 2017	Meeting #3 (Burlington, MA)
March 7, 2017	Telecon #10
April 4-6,2017	Meeting #4 (Cologne, Germany)
May 2, 2017	Telecon #11
June 6, 2017	Telecon #12

Table 10-2: Meetings/Telecons held

Appendix C - Table of engine installation-related regulations

The table below was established by a regulator sub-group of the EACWG.

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
Propulsion System Definition	21.31 21.41; 33.4 5 28(a)	901(a)(b) 1163 1167	20	901(a)(b) 1163 1167		Aircraft-level guidance on part 25 requirements that must be complied with in the engine design is not readily available to engine manufacturers and part 33 authorities	Aircraft certification has a specific definition of the powerplant system, which includes the engine. Therefore, all aircraft powerplant requirements are applicable to the engine unless specifically exempted.	Already captured by EACWG
Limitations, Installation Instructions, and Manuals	4 5 7 App A 14 23(a) 27 28(a) 28(d) 66 87 88 90 91(b) 93 99(b) 49 53(b) 55 57(b) 28(a) 65 66	901(b)(1)(i)(3 3.5) 901(b)(2) 1501(a)(1503 –1533) 1501(b)(1541 –1587) 1521(a)(b)(c) 1521(d)(1043 (b) 1529 1583(b)(1)(15 21 1522 1583(b)(2)(3)(1549-1553)	20, 25, 30, 40 Note: Manuals (Installation, Operation) required by CS-E 20 are distinguished from ICA required by CS-E 25.	901(b)(1)(i)(3 3.5) 901(b)(2) 1501(a)(1503 –1533) 1501(b)(1541 –1587) 1521(a)(b)(c) 1521(d)(1043 (b) 1529 1583(b)(1)(15 21 1522 1583(b)(2)(3)(1549-1553)	YES	- Engine manufacturers don't include all engine requirements in § 33.4 submittal because aircraft manufacturers want on-wing requirements in aircraft manual, and engine manufacturers don't want to have to maintain the data in two places. (e.g. EWIS requirement)	Assumptions about aircraft operations or configurations are sometimes made by the engine manufacturer that are not well communicated to the installer.	Already captured by EACWG

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
		1585(a)(b)(953) 1585 (c)(251) 1585(d)(e) 1587		1585(a)(b)(953) 1585 (c)(251) 1585(d)(e) 1587		- Confusion as to what goes in the operating manual and what goes in the installation manual.		
Failure / Safety Analysis (including thrust control malfunction / uncontrollable high engine thrust)	19(a) 28(b) 28(c) 74 75	901(c) 903(b) 1309	50, 510	901(c) 903(b) 1103(d) 1309	YES	The part 25 authorities (& other aircraft-level authorities) infer from the wording of § 33.75 that an IFSD (in-flight shutdown) always has only a minor effect, and that the part 33 authorities consider IFSD minor. Guidance update may be required to call out § 33.28 ("The rate for Loss of Thrust (or Power) Control (LOTC/LOPC) events, consistent with the safety objective associated with the intended application can be achieved"), endurance test, IMI test, Early ETOPS test, etc. as evidence that	Aircraft certification relies on engine certification results to feed aircraft system safety assessments (Failure rates) – exposure time shall be consistent with aircraft assumptions Safety objectives are different: -No single failure criterion in aircraft requirements. -IFSD hazard classification : MAJOR vs MINOR	NEW. This group recommends the FAA should review the FAA Course 21021 Propulsion Engineering Job Functions to ensure interface issues are adequately identified. [Consider revising any similar EASA training.]

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
						part 33 requires adequate engine reliability.		[Consider publicizing the list of interface issues to industry upon completion of the EACWG report] [Revise safety policies to highlight differences between part 33 & 25 methodologies.] Intentional disconnect between aircraft and engine system safety analysis standards. Engine certification

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
								standards are limited to a single engine. Airplane certification standards are based on aircraft safety which depends on the number of engines which can vary.
Starting	5(b)(3) 69 87(b)(6) 87(c)(6) 87(d)(7) 87(g)(3) 89(a)(1) 37 51 96(c)	901(b)(c)903(b)(e) 1141(f) 1145(a)(b) 1163(a)(3) 1165(c) 1301(a)(b)(c)(d) 1305(c)(4) 1351(d) 1353(c)(5)(6) 1461(c)	910	901(b)(c)903(b)(e) 1141(f) 1145(a)(b) 1163(a)(3) 1165(c) 1301(a)(b)(c)(d) 1305(c)(4) 1351(d) 1353(c)(5)(6) 1461(c)	YES	When defining the engine air start envelope, there is no 'quick start' requirement at part 33 level, but there is one at the aircraft level.	Extensive flight testing is required. Aircraft level EASA CRI and FAA issue paper have specific flight test requirements that may impact engine design (including "quick start"). Draft ARAC recommendations for part 25 / CS-E rulemaking.	Quick start issue—NEW to EACWG. Recommend part 25/CS-25 publish policy to formalize IPs/CRIs & complete rulemaking. Rotor lock--Already captured by

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
							Extensive engine manufacturer and aircraft manufacturer coordination needed for rotor lock – addressed by the FAA in part 33 & part 25 complementary policy statements.	EACWG— Recommend FAA & EASA outreach to industry to educate the complimentary nature of the policy and need for evaluation at both engine and aircraft level.
Powerplant Operating Characteristics	5(b)(3)(ii) 5(b)(3)(iii) 7(c)(13) 65 66 73 87(b)(5) 87(c)(5) 87(d)(6) 89 97 47 51	901(a)(b)(33.5) 901(b)(2) 903(a)(1)(2)(3 3.77 33.78) 939(a)(c) 1305(d)(3)	500	901(a)(b)(33.5) 901(b)(2) 903(a)(1)(2)(3 3.77 33.78) 939(a)(c) 1305(d)(3)	YES			See Note on blanks.
Powerplant Performance & Limits Evaluation	5(b)(2) 7 8 27 28(a) 29(a) 83 85 87 88 93 94 45 49 55	101 119 121 901(b)(33.5) 903(a)(33.77 33.78 903(d)(2) 939	20, 40	101 119 121 901(b)(33.5) 903(a)(33.77 33.78 903(d)(2) 939	YES	- Engine and aircraft manufacturers request ratings that are not in the regulations, with inadequate coordination	Aircraft requirements are based directly on engine performance and limits defined by the engine	NEW Recommend developing a work

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
		941 1305(b) 1305(c)(1)(3) 1305(d)(1)(e)(1) 1587		941 1305(b) 1305(c)(1)(3) 1305(d)(1)(e)(1) 1587		between engine and aircraft authorities (even when that coordination appears to be extensive and early). - Confusion about the requirement that engines must always be capable of performing to their defined ratings (new production engines, overhauled engines, engines about to be removed for maintenance/overhaul). - Part 33 has 5-second acceleration requirement. Part 25 has an 8-second climb condition requirement. Engine could fail 5-second acceleration requirement but aircraft with that engine might meet the 8-second climb requirement. Part 33	manufacturer. Aircraft manufacturer may want to impose different limits which will require coordination.	instruction or Order requiring part 33 & part 25 authorities to communicate interface issues at the start of a program or immediately after they arise.

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
						exemption required in that case.		
Fuel, Oil, Hydraulic Fluids Designations and Specifications	33.7	901(b)(1), 901(c)(1), 1521(c)(2), 1557(b)(1), 1583 (b)(1),	20(d), 25(c)(4), 560(a)	901(b)(1), 901(c)(1), 1521(c)(2), 1557(b)(1), 1583 (b)(1),	YES	Part 33.7, Engine ratings and operating limitations, requires approved fuels and oils to be listed in the type certificate data sheet.	Some instances of aircraft flight manual identifying fuels approved for the aircraft that were not approved for the engine. Another instance of specific engine limitations for one fuel not carried over into aircraft flight manual.	Already captured by EACWG (refer to Limitations, Installation Instructions, and Manuals).
Fuel Contamination	33.67	951 952 977 997(d) 1309(c) 1322	560, 670	951 952 977 997 1309(c) 1322	YES	Fuel bypass & blockage systems require indication in cockpit per part 25 policy	FAA issue paper for some designs that may have potential blockage source with or without flight deck bypass indications that could significantly delay indication of multi-engine fuel system gross contamination. May require engine design changes to	Recommend review of part 33 and part 25 policies to ensure they are consistent.

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
							accommodate bypass means and/or indication of bypass.	
Fuel Systems	7(b)(2) 7(b)(5)(i) 7(c)(2) 7(c)(5)(iv) 7(c)(6)(i) 7(c)(9) 21 29(a) 67 79 87(a)(7) 93 35 47	951(part 34) 952 953(903(b) 954 955 957 959 961(a)(1527)(b) 963(a)(b)(c)(d)(561) (c)(f) 965 967(a)(b)(c)(1 185(a)) 967(c)(e) 969(979(b)) 971 973 975 977 979 981 991 993 994 995 997(a)(b)(c)(d)(part33) 999 1001(a)(119 121(d))	560, 670	951(part 34) 952 953(903(b) 954 955 957 959 961(a)(1527)(b) 963(a)(b)(c)(d)(561) (c)(f) 965 967(a)(b)(c)(1 185(a)) 967(c)(e) 969(979(b)) 971 973 975 977 979 981 991 993 994 995 997(a)(b)(c)(d)(part33) 999 1001(a)(119 121(d))	YES	Redundant issue papers (e.g., ice-in-fuel--same requirement). No issued guidance.	Fuel icing issue papers for both engine and aircraft certification. Aircraft issue paper requires demonstration of worst-case threat. There have been interpretation differences on allowable thrust loss. Redundant requirements (e.g., fuel filters) in part 25 to accommodate type certificated engines prior to part 33 adoption of corresponding requirements.	Already covered by EACWG. This group recommends EASA / FAA develop joint guidance. This group recommends revising certification standards to eliminate redundancy, remove antiquated prescriptive standards where possible and

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
		1001(b)(119 121(d)) 1001(c)(d)(e)(f)(g) 1011 1305(a)(1) 1305(a)(2) 1305(b)(4)(5) 1305(c)(2) 1305(c)(6)(997) 1305(c)(8) 1337(b)(959) 1337(c)(f) 1316		1001(b)(119 121(d)) 1001(c)(d)(e)(f)(g) 1011 1305(a)(1) 1305(a)(2) 1305(b)(4)(5) 1305(c)(2) 1305(c)(6)(997) 1305(c)(8) 1337(b)(959) 1337(c)(f) 1316				standardize how engine requirements are introduced at the aircraft level (e.g., § 25.903(a) references to specific part 33 requirements by amendment level).
Powerplant Control Systems	5(a)(2) 19(b) 27(b) 28 29(a) 29(c) 75(d) 79 87(a)(2) 91 53	779(b) 781 901(a)(b)(33.5)(c) 903(a)(part 34, 33.7 33.78) 903(b)(c)(d)(2) 904 1141 1143 1145 1147 1323	50	779(b) 781 901(a)(b)(33.5)(c) 903(a)(part 34, 33.7 33.78) 903(b)(c)(d)(2) 904 1141 1143 1145 1147 1323	YES	-No specific guidance on what level of software or software features (e.g., multiple triggers) are required when using software to prevent an engine hazard. Aircraft manufacturer desire to turn off engine features	Flight test demonstration for changes to FADEC software.	Already covered by EACWG

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
		1325 1555(a)(c)(d)(1) 1316		1325 1555(a)(c)(d)(1) 1316		used for compliance to part 33 requirements. -No specific guidance on the applicability of ARP4754A/ ED-79A to engine control systems.		
Software and Hardware Development	33.28, 33.91	901 1301 1309	50	901, 1309	YES	No guidance or requirements at engine level on EWIS, though part 25 applies it to engine cables/wiring harnesses. (Impacts ICAs)	Aircraft requirements applied to engine may not have specific guidance available on how to apply to the engine (e.g., EWIS).	Already covered by EACWG
Reverser Systems	15 83 85 87 89 93 95 97 (Note: the following are also evaluated as part of a 33 certification: 4 5 15 17 21 23 63 65 72 75 90 91)	933(35.21) 934(33.97) 1141(777-781, 1555) 1155 1305(d)(2)	10, 890	933(35.21) 934(33.97) 1141(777-781, 1555) 1155 1305(d)(2)	YES	Confusion at aircraft level about when a non-type design thrust reverser may be used and during which engine tests the thrust reverser must be actuated.	Several equivalent safety findings issued to accommodate non-production representative thrust reversers installed on part 33 certification tests. There is a lack of guidance on how to address aircraft requirements (such as	Already covered by EACWG Some alleviation is provided in updated guidance with issuance of AC 20-18B, which gives extensive

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
							25.1309) when the reverser is included as part of the engine type certificate.	guidance on this subject. Need for clarification that part 25 regulatory requirements must still be met (at aircraft level) when thrust reverser is included as part of the engine type certificate. Consider clarifying engine-level guidance to make clear that part 33 certification of a thrust reverser does not address installation

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
								requirements on an aircraft.
Oil Systems	7(b)(3) 7(b)(4)(ii) 7(b)(5)(ii) 7(c)(3) 7(c)(5)(i) 7(c)(6)(ii) 7(c)(10) 17(c) 21 29(a) 71 72 74 87(a)(4) 87(a)(7) 93 39 49(a) 55	943(333) 1011 1013(967) 1015(965(a)(c)) 1017(993 1183) 1019(Part33, 1305(c)(7)) 1021 1023 1025(1189) 1027 1305(a)(4)(5)(6) 1305(c)(7)(10 19) 1337(d) 1557(b)(2)	570	943(333) 1011 1013(967) 1015(965(a)(c)) 1017(993 1183) 1019(Part33, 1305(c)(7)) 1021 1023 1025(1189) 1027 1305(a)(4)(5)(6) 1305(c)(7)(10 19) 1337(d) 1557(b)(2)	YES	Appendix A to part 33 section A33.1 requires that the ICA includes servicing information that covers details regarding servicing points, capacities of tanks, reservoirs, types of fluids to be used, pressures applicable to the various systems, locations of lubrication points, lubricants to be used, and equipment required for servicing.	Lack of clear guidance on oil endurance when applied to ETOPS. Engine manufacturer data required to support aircraft manufacturer analysis on oil system capacity. Potential for engine design to limit aircraft diversion time. FAA will address at the airplane level in pending draft ETOPS AC 25.1535-X.	Already covered by EACWG. Recommend part 33 / CS E guidance on what data is needed by the installer to satisfy aircraft level ETOPS requirements.
Fire Protection / Prevention	15 17 75(a) 91(a)	859(a)(1181-1191, 1195-1203) 859(b)(c)(d)(e)(f)(g)(1121 1123) 859 (h) 863 865 867 869(831 863	130	859(a)(1181-1191, 1195-1203) 859(b)(c)(d)(e)(f)(g)(1121 1123) 859 (h) 863 865 867 869(831 863	YES	Guidance in AC 20-135 requires update.	Engine compliance demonstration have been reused for A/C compliance demonstration:	Already covered by EACWG Note: AIA task in progress.

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
		1183) 903(c)(d)(1) 929(b)(1181-1185, 1189) 952(b) 954 963(d)(561)(e)(2) 967(a)(2)(b)(c) (1185(a)) 967(d)(e) 973(b)(c)(d) 975(a)(6)(b) 979(a) 981(a)(b) 993(d)(e)(f) 994 995(1189) 1001(d)(1) 1013(a)(967) 1013(e) 1017(a)(993 1183) 1017(b)(2)(3) 1023(b) 1025(a)(1189) 1141(e)		1183) 903(c)(d)(1) 929(b)(1181-1185, 1189) 952(b) 954 963(d)(561)(e)(2) 967(a)(2)(b)(c) (1185(a)) 967(d)(e) 973(b)(c)(d) 975(a)(6)(b) 979(a) 981(a)(b) 993(d)(e)(f) 994 995(1189) 1001(d)(1) 1013(a)(967) 1013(e) 1017(a)(993 1183) 1017(b)(2)(3) 1023(b) 1025(a)(1189) 1141(e)			Firewall, Valves, Flammable Fluid lines Different pass/fail criteria Different operating conditions Use of Burner Fireproof Engine mounts Fire resistant FADEC Residual burning Material vs installation Fire size Shut-off means Engine combustor burn through Electrical Harness Oil tanks	

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
		1181(859 867 1185-1203) 1182(1103(b) 1165(d)(e) 1183 1185(c) 1187 1189, 1195-1203) 1183 1185(1183(a)) 1187 1189(1181(a)(4)(5)) 1191 1192(1191) 1193(1187 1191) 1195 1197 1199 1201 1203 1207(1181-1203) 1305(a)(7) 1316 1322 1337(1)(993 1183) 1337(2)(3) 1351(b)(2)(4)(d) 1353 1357 1435(c)(863		1181(859 867 1185-1203) 1182(1103(b) 1165(d)(e) 1183 1185(c) 1187 1189, 1195-1203) 1183 1185(1183(a)) 1187 1189(1181(a)(4)(5)) 1191 1192(1191) 1193(1187 1191) 1195 1197 1199 1201 1203 1207(1181-1203) 1305(a)(7) 1316 1322 1337(1)(993 1183) 1337(2)(3) 1351(b)(2)(4)(d) 1353 1357 1435(c)(863				

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
		1183 1185 1189)		1183 1185 1189)				
High Energy Rotor	4 7(b)(7) 7(c)(12) 7(c)(14) 7(c)(15) 14 15 19(a) 21 27 62 63 74 75(b) 83 87 88 90 93 94	903(d)(1) 905(d) 1461 571(e) 365(e)(1) 841(a)(2)(3)	510, 840	903(d)(1) 905(d) 1461 571(e) 365(e)(1) 841(a)(2)(3)	YES	Part 33 (§ 33.19) requirements are clear—trajectory and energy of material (pieces) that exits the engine forward of the engine forward flange or aft of the aft flange(s) must be "defined." Practice is to include that data in the installation manual.	Aircraft manufacturer needs engine data from Engine manufacturer: speed, geometry. Assumptions for aircraft certification on engine blade failures modes may be stricter than what was used for engine certification (e.g., fan blade failure at the root vs. aero flow path). Aircraft policy has standard trajectories for engine blade fragments whereas the engine manufacturer may show larger trajectories.	Recommend part 25 policy be changed to require aircraft manufacturer to consider actual engine containment test results in aircraft safety analysis. Also, that if engine certification basis allows containment of less than a whole blade, aircraft manufacturer still must consider release of a

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
							Fan Blade fragment release assessment – fan blade out containment test gives only partial relief to the aircraft hazard minimization requirements (not included in 1/20). Aircraft manufacturer requires engine data to evaluate fan blade trajectories.	whole blade for design risk minimization purposes.
Icing	5(b)(1) 68 77(c)	929(a)(b)(1181-1185 1189) 1093 1305(c)(5) 1323(e) 1325(b) 1419 App C 1419(d)	780	929(a)(b)(1181-1185 1189) 1093 1305(c)(5) 1323(e) 1325(b) 1419 App C 1419(d)	YES	Aircraft requirements *appear* to be redundant with engine requirements, when reading the text. Flight Standards allows operation of transport aircraft in snow in conditions outside the conditions assumed for	CS 25.903 does not refer to a specific CS E 780 Amdt whereas 14 CFR does. Clarification needed on use of the declared ice ingestion capability of engine Critical point analysis A for CS-E and part 33 is different	Already covered by EACWG This group recommends EASA/FAA validation process work issues on significant standard differences.

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
						certification (higher snow concentrations).	Ice crystal icing: aircraft requires more than a comparative analysis – flight test may be required to validate analysis tools. Snow was not always required at engine level Freezing fog: aircraft may have to expand the engine data envelope to cover their sought operations (establishing limitations)	Flight Standards allows operation of transport aircraft in snow conditions outside the conditions assumed for certification (higher snow concentrations). 1) Recommend AIR work with Flight Standards to resolve this difference and issue appropriate guidance.

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
								2) EACWG should recommend further review of Certification vs. Operational requirements to look for other gaps.
Induction System and Foreign Object Ingestion / Damage	5 76 77 78 35	903(a)(2)(33.77 33.78) 1091(d)(2) 1091(e)(33.77) 1455(blue ice)	540, 780, 790, 800	903(a)(2)(33.77 33.78) 1091(d)(2) 1091(e)(33.77) 1455(blue ice)	YES	Part 33/ CS E has standard ice slab size	Part 25 / CS-25 requires assessment of installation to ensure ice ingested is equal to or smaller than the part 33 / CS E ice slab.	Not a conflict— covered by AC 20-147A and EASA AMC material.
Air Contamination	33.75(g)(2)(ii)	831(b) 832 901(c) 1309	690	831(b) 832 901(c) 1309	YES	Part 33.75 only addresses flight hazards (sufficient to incapacitate crew or passengers).	CS-25/part 25 only limit CO, CO_2 and ozone levels. Aircraft certification relies on engine certification data.	See Note on blanks.

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
Powerplant/ Propeller Vibration	5 7(c)(13) 29(b) 63 83 87(b)(4) 87(c)(4) 87(d)(5) 91(a) 97(a) 93 33 43 49 55	771(e) 901(a)(2) 903(c) 939(c) 965(b)(c) 1203(b)(1) 1305(d)(3) 1321(d)(e) 1322	100, 520, 650	771(e) 901(a)(2) 903(c) 939(c) 965(b)(c) 1203(b)(1) 1305(d)(3) 1321(d)(e) 1322	YES	Part 35 § 37.37, Fatigue Limits and Evaluation, says that "(2) Expected service deterioration, variations in material properties, manufacturing variations, and environmental effects. (c) A fatigue evaluation of the propeller must be conducted to show that hazardous propeller effects due to fatigue will be avoided throughout the intended operational life of the propeller on either: (1) The intended airplane by complying with Sec. Sec. 23.907 or 25.907 of this chapter, as applicable; or (2) A typical airplane.]"	Aircraft is using the engine / propeller vibration source data Sustained Engine Imbalance evaluation required at : structure, systems and human factors levels Aircraft requires vibrations indications (not required for turboprop installations)	Not a conflict. Sustained engine imbalance is addressed by AC 25-24.

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
Propulsion System Loads	5(a)(1) 23 74 75(c) 94	571 901(c) 903(c) 905(d) 361(333(b)) 363(333(b))	100, 520	571 901(c) 903(c) 905(d) 361(333(b)) 363(333(b))	YES	Section 33.5 says the installation manual must include "(1) The location of engine mounting attachments, the method of attaching the engine to the aircraft, and the maximum allowable load for the mounting attachments and related structure."	Aircraft certification relies on engine manufacturer data and analysis results.	See Note on blanks.
HIRF and Lightning	5 28(d) 89(b) 91(a)	581 901(b)(4)(c) 954 1316	50, 80, 170	581 901(b)(4)(c) 954 1316	YES	Engine effects depend on aircraft connections and configuration.	Aircraft certification relies on engine manufacturer data and analysis results.	See Note on blanks.
External Accessories	4 5(a)(2) 7(b)(6) 7(b)(7) 7(c)(7) 7(c)(8) 19(b) 25 29 72 82 87(a)(6) 91 93(a)(1) 93(b)(1) 42 53 55(b) 55(c)	943 1163 1167(33.25 33.49 33.53 33.87 33.91) 1305 1337	20, 80	943 1163 1167(33.25 33.49 33.53 33.87 33.91) 1305 1337	YES	Section 33.5 requires the installation manual include this information.	Aircraft manufacturer relies on engine installation instructions.	See Note on blanks.

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
Cooling	7(b)(4) 7(c)(5) 21 91(b) 39(b) 53(b)	961 1041 1043 1045 1125(a)(3) 1127(b) 1521(b)(3)(4)(c) (3)(4)(d)	860	961 1041 1043 1045 1125(a)(3) 1127(b) 1521(b)(3)(4)(c) (3)(4)(d)	YES	Section 33.5 requires "(5) Where an engine system relies on components that are not part of the engine type design, the interface conditions and reliability requirements for those components upon which engine type certification is based must be specified in the engine installation instructions directly or by reference to appropriate documentation.	Aircraft manufacturer relies on engine installation instructions. Specific aircraft flight tests required.	See Note on blanks.
Flight Deck Controls and Displays	5(a)(2) 29 66 71(b)(6)	771 777 779(b) 901(a)(2)(b)(1)(33.5) 903(b)(c)(d)(2) 1141 1142 1143 1145 1147 1149 1153 1155 1157 1159 1161 1165(g) 1189(f)	60	771 777 779(b) 901(a)(2)(b)(1)(33.5) 903(b)(c)(d)(2) 1141 1142 1143 1145 1147 1149 1153 1155 1157 1159 1161 1165(g) 1189(f)	YES	Aircraft-level guidance on part 25 requirements that must be complied with in the engine design is not readily available to engine manufacturers and part 33 authorities.	Automatic functions at engine level may require aircraft indications (e.g., ice protection systems). Additional engine systems data indicated at aircraft level might be required (fuel bypass, icing, fuel flow) to indicate a potential unsafe system state	Refer to fuel contamination and fuel systems recommendation.

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
		1203(b)(2)(3)(d) 1301 1303 1305 1307 1309 1321(a)(c) 1322 1325(f) 1326 1329 1335 1337 1351(b)(5)(6) 1357(d) 1501(b) 1541 1543 1549 1553 1555(a)(b)(c)(d)(1)		1203(b)(2)(3)(d) 1301 1303 1305 1307 1309 1321(a)(c) 1322 1325(f) 1326 1329 1335 1337 1351(b)(5)(6) 1357(d) 1501(b) 1541 1543 1549 1553 1555(a)(b)(c)(d)(1)			requiring flightcrew action or awareness (e.g., aircraft issue paper on gross fuel contamination indications).	
Function and Reliability (F&R) Testing	90 91(a) 49 53(a)	21.35(f)	740	21.35(f)	YES	A type certificated engine should experience relatively few problems during aircraft F&R testing unrelated to aircraft integration requirements. Success depends on aircraft certification flight testing being done with	While an independent requirement in part 21 for the aircraft, success largely depends on how mature the engine design is and how thoroughly it is tested, accounting for installation issues, by	Already covered by EACWG. Recommend aircraft manufacturers work with the engine

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
						engines as close to final type design as possible. Risk increases if flight test is performed prior to engine certification or before early ETOPS testing is completed.	the engine manufacturer.	manufacturers to ensure smooth F&R testing.
Extended Operations (ETOPS) for FAA & Extended Range Operations with Two-Engine aircraft (ETOPS) for EASA	201	21.4 3 1535 App K	1040	1535 AMC 20-6 rev 2	YES	- Roles and responsibilities of aircraft and engine manufacturer are not always clear for the § 33.201 simulated ETOPS mission cyclic endurance test / propulsion system validation test since there are requirements for both engine and aircraft on the same test. Joint guidance may be necessary - No clear guidance on when an aircraft Early ETOPS flight test demonstration is required for design changes (e.g., new engine models, etc.)	ETOPS has specific engine certification requirements (§ 33.201 & in AMC 20-6 rev 2). Aircraft requirement to include nacelle package in § 33.201 test. Aircraft reliability assessment requires data from engine manufacturer.	FAA is working on draft AC 25.1535-X to address ETOPS policy, including type design changes and flight testing required. Several recent projects have included coordination at aircraft and engine level, including both

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
						when part 33 has determined no new § 33.201 test is necessary.		certifying and validating authorities and joint agreement/ approval on test plan. See above recommendation for part 33 and CS E policy.
Noise and Engine Emissions	1(b); also refer to 14 CFR 34 for engine emissions	Part 34, Emissions Part 36, Noise	1010	Part 34, Emissions Part 36, Noise	YES	Part 21 does not require compliance with part 36 at the engine level because the noise level depends on installation.	While a separate aircraft evaluation is required, the overall aircraft noise level is highly dependent on the engine design. Engine design changes may be needed to meet aircraft noise requirements.	See Note on blanks.
Volcanic Ash	None	None	540, 1050	25.1593	YES	Engine guidance in development.	Potential engine limitations in volcanic	Already covered by EACWG (refer

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
							ash could limit aircraft operation. Not aligned between CS-25 and 14 CFR part 25.	to Limitations, Installation Instructions, and Manuals)
EWIS	None	1701 1703 1705 1707 1709 1711 1713 1715 1717 1719 1721 1723 1725 1727 1729 1731 1733	None	1701 1703 1705 1707 1709 1711 1713 1715 1717 1719 1721 1723 1725 1727 1729 1731	YES	Part 33 does not require EWIS compliance.	Aircraft certification requirements apply to powerplant, which includes the engine. There are no corresponding EWIS requirements in part 33 / CS-E. There is also no aircraft level guidance available to address EWIS for engines. However, some part 33 / CS-E requirements indirectly meet EWIS requirements.	Already covered by EACWG. Recommend part 33 & part 25 generate policy explaining what is required of the engine design and ICA to meet part 25 EWIS requirements.
Master Minimum Equipment List	33.28	901(b)(2) 901(c) 1309 1529 App H	1030		YES	Part 33 policy available.	Engine time-limited dispatch requirements feed directly into aircraft MMEL.	See Note on blanks.

Issue/ Topic	Part 33	Part 25	CS-E	CS-25	Inter-dependencies?	If yes, provide description from engine perspective	If yes, provide description from aircraft perspective	Remarks
/ Time Limited Dispatch								
APU Installations	None. (TSO-77b, CS-APU)	901(d) 903(f) Draft App K	None.	901(d) 903(f) Draft App K	NO	There are no APU requirements in part 33 / CS-E. APU requirements are in TSO-77b / CS-APU.	APU interface requirements are defined at the aircraft installation level (e.g., bleed requirements for engine starting).	This group recommends FAA / EASA review APU interface issues in a follow-on activity.
Propeller installations		905(a)(b)(c)(35.42) 905(d) 907 925(a)(b)(239(a)) 925(c) 929(a)(b)(1181 1185 1189 933(b)(1)(2)(35.21)	CS-P 30	905(a)(b)(c)(35.42) 905(d) 907 925(a)(b)(239(a)) 925(c) 929(a)(b)(1181 1185 1189 933(b)(1)(2)(35.21)	YES	Engine type certificate may include reduction gearbox and have specific propeller interface requirements.	Aircraft requirements to integrate propeller TC and engine TC, including installation instructions.	This group recommends FAA / EASA review propeller interface issues in a follow-on activity.

Note: Some changes made include regulations referenced within the regulation. The referenced regulation is shown in brackets after the paragraph it resides in. This is especially useful to show the references made to part 33 within part 25 and it also serves to show how integrated part 25 is. Example: under Fire Protection we have listed regulation 25.859(a), as 859(a)(1181-1191, 1195-1203), listing the other part 25 regulations mentioned within 25.859 in brackets which are 25.1181 through 25.1191 and 25.1195 through 25.1203.

Note on blanks: This group did not identify any specific interface issues experienced on recent projects even if there is a clear dependency between aircraft and engine certification. We contribute this to existing policy, guidance and regulatory requirements or existing working relationships between engine and aircraft manufacturers.

Appendix D - Questionnaire and results

Engine & Aircraft Certification Process Questionnaire (July 2016)

Instructions: Read each item carefully then mark the response that best describes your experience with potential issues that may have adversely impacted certification.

Filled questionnaire should be send to engine_aircraft_certsurvey@easa.europa.eu

Feedback Requested by: August 31, 2016

European Aviation Safety Agency (EASA) and Federal Aviation Administration (FAA) experience on several recent certification programs highlighted the fact that the current approach of having two totally independent certification processes for engine and large transport airplanes might have some limitations.

Designing, certifying, and producing turbine engines and large transport airplanes are two very different businesses; however, in the end both are integrated into the same final product. We have had experience recently where engine certification issues have been raised during the aircraft certification program despite in some cases, that the engine was previously type certificated. These issues in turn have led to duplication of effort by the various authority and industry stakeholders and ultimately impacted the aircraft certification program schedule in some instances.

As such, EASA and FAA agreed to launch an ad-hoc working group to take a critical look at our current approaches to engine and aircraft type certification.

The purpose of this group is to conduct an in-depth review of our current certification practices and processes, and to develop recommendations by June 2017 on changes to streamline and improve the overall process. The scope of the working group is engines installed in transport category aircraft. The group will make recommendations on future follow-on work for the other product categories.

In order to obtain a manageable and efficient working group, the number of participants has been deliberately limited. The group includes industry representatives from engine and large transport airplane manufacturers.

In order to gain broader perspectives, the group has produced this questionnaire to gather feedback from stakeholders not directly represented in the group. This questionnaire is also being sent to Transport Canada Civil Aviation (TCCA) and Agência Nacional de Aviação Civil (ANAC), and their industry, due to the potential global industry impact.

We appreciate your participation. The group will consider your feedback and use it to develop recommendations on changes to streamline and improve the overall certification process.

The questions have been split into 6 groups as follows:

A. Communication and/or Timing
B. Duplication of Work
C. Gap in Requirements
D. Process
E. Rules and Interpretation
F. Technical

The majority of the questions are answered by a direct Yes or No and then a free text field. The main benefits of the questionnaire will come from the free text fields and you are encouraged to give explanations and provide examples. The inputs to the questionnaire will be shared with the regulator/industry group, so please provide examples in a way that can be shared.

Please provide enough detail for the group to understand and use your examples, while understanding that we may share the results of the questionnaire with different authorities or industry participants. We will review your answers and if we have any doubt about the releasability of certain details, we will contact you for clarification.

Besides the responses to the questions, responders are also invited to share their experience, lessons learned, best practice, recommendations, etc.

If you have additional thoughts on this subject that are not covered by the questions, please provide them in Group I at the end of the survey.

The Attachment to this survey provides some certification issue examples the team discussed. These examples are intended to provide additional context only and are not intended to be all inclusive or limit/influence the type of feedback provided.

The results of the questionnaire will be available to you. If you have any questions about the questionnaire results, please contact [insert email address].

Thank you for taking your time to complete this questionnaire and provide your comments.

Engine & Aircraft Certification Process Questionnaire (July 2016)

Group A	The following questions ask about your experience related to **communication and timing**

A.1	**Do you have experience where the engine/airframe interface requirements have been fixed later than would be optimum by the manufacturers, or where regulatory requirements on the engine and airframe are inconsistent and this has not been recognized at an early stage?** ☐Yes (Please describe) ☐No Description: *Please give examples, including the consequences of the late definition or inconsistent requirements, and thoughts on the root causes, and your views on what should be done to prevent similar occurrences.*

A.2	**Do you have experience where clear and timely communication between the engine manufacturer, aircraft manufacturer, engine airworthiness authority, and/or aircraft airworthiness authority did not occur?** ☐Yes (Please describe) ☐No Description: *Please give examples, any thoughts on root cause, and your views on what should be done to prevent similar occurrences.*

A.3	**Do you have experience of aircraft activities which resulted in changes to rules, specifications, guidance or standards mandated by CRI/issue paper where the engine was impacted and the engine community was not sufficiently involved, or vice versa?** ☐Yes (Please describe) ☐No Description: *Please give examples, including consequence, and thoughts on the root causes, and your views on what should be done to prevent similar occurrences.*

A.4	**Do you have experience where completion of engine instructions for continued airworthiness (ICA) was deferred until after engine type certification (TC) and this resulted in flight test or engine integration problems?** ☐Yes (Please describe) ☐No Description: *Please give examples, including consequences, and thoughts on the root causes, and your views on what should be done to prevent similar occurrences.*

Group B	The following questions ask about your experience related to **duplication of work**

B.1	**Do you have experience where aircraft verification/testing which was carried out, either by decision of the aircraft manufacturer or because required by the authority, when verification of the requirements in question had already been completed at engine level?** ☐Yes (Please describe) ☐No Description: *Please give examples, including consequence, and thoughts on the root causes, and your views on what should be done to prevent similar occurrences.*

B.2	**Do you have experience where some aspect of engine certification compliance has been reinvestigated during aircraft certification because of a proven or perceived lack of compliance, or because authorities at aircraft level wish to investigate directly?** ☐Yes (Please describe) ☐No Description: *Please give examples, including consequence, and thoughts on the root causes, and your views on what should be done to prevent similar occurrence (if considered appropriate).*

Group C	The following questions ask about your experience related to **gaps in requirements**

C.1	**Do you have experience where aircraft testing in the installed configuration was required, to address an area that is expected to be fully covered during engine certification? If yes, was the root cause** **a) The engine verification did not meet the engine certification requirement** **b) The engine certification requirement doesn't fully cover the topic – though it could be changed to cover it without much difficulty** **c) The engine certification requirement does cover the topic, but it was considered that compliance with the certification requirement could not be fully shown without aircraft testing?** **d) Other?** ☐Yes (Please describe) ☐No Description: *Please give examples, identifying whether you believe the root cause was associated with inadequate engine certification requirements, or a failure of the engine type investigation program to fully meet the engine certification requirement. Please provide any other insights you have on root cause and what should be done to prevent further occurrences.*

C.2	**Do you have experience of issues arising during aircraft certification that you might reasonably have expected not to occur with a certified engine?** ☐Yes (Please describe) ☐No Description: *Please give examples? What do you consider to be the root cause? Was it a failure of the engine to meet the requirements it had been certified against, or an issue with the engine certification requirements that means engines are not optimised to support aircraft certification?*

Group D	The following questions ask about your experience related to **process**

D.1	**Do you have experience of difficulties achieving timely identification, escalation and resolution of engine/aircraft interface issues including projects involving different engine and aircraft states of design?** ☐Yes (Please describe) ☐No Description: *What do you think the root cause was? Do you believe there are adequate processes to achieve this? If not what do you think is needed?*

D.2	**Do you have experience of industry finding it difficult to question/escalate decisions to apply aircraft certification requirements/policies to engines, or to question why an engine certification requirement doesn't adequately cover an aircraft certification requirement?** ☐Yes (Please describe) ☐No Description: *Please give examples. Do you believe there are adequate processes to achieve this? If not what do you think is needed?*

D.3	**Do you have experience where lack of clear responsibilities/boundaries/best practice guidance led to late identification of issues and duplication of certification activity?** ☐Yes (Please describe) ☐No Description: *Please give examples. What were the consequences? What do you think needs to be done to prevent future similar occurrences?*

D.4	**Do you have experience where all data necessary for aircraft certification was not produced during engine certification or not included in engine installation manual?** ☐Yes (Please describe) ☐No Description: *Please give examples. What were the consequences? What do you think needs to be done to prevent future similar occurrences?*

Group E	The following questions ask about your experience related to **rules and interpretation**

E.1	**Do you have experience of where aircraft/engine interface certification requirements were not clearly defined or not aligned sufficiently early in the certification programs?** ☐Yes (Please describe) ☐No Description: *Please give examples. What were the root causes? What were the consequences? What do you believe should be done to avoid future occurrences?*

E.2	**Do you have experience with conflicting safety considerations in aircraft/engine certification requirements?** ☐Yes (Please describe) ☐No Description: *Please give examples. What were the root causes? What were the consequences? What do you believe should be done to avoid future occurrences?*

E.3	**Do you have experience with inconsistent application of existing aircraft and engine certification requirements, policies, or interpretations, including those found acceptable on prior certification programs?** ☐Yes (Please describe) ☐No Description: *Please give examples. What were the root causes? What were the consequences? What do you believe should be done to avoid future occurrences?*

E.4	**Do you have experience with introduction of new policy, requirements, or interpretations at aircraft level that affected the engine certification program after the engine certification basis was agreed and part way through the engine type investigation program?** ☐Yes (Please describe) ☐No Description: *Please give examples. What were the root causes? What were the consequences? What do you believe should be done to avoid future occurrences?*

E.5	**Do you have experience with aircraft certification requirements affecting the engine not reflected in engine certification requirements, or vice versa?** ☐Yes (Please describe) ☐No Description: *Please give examples. How were the requirements managed? What were the consequences? Should this be addressed, and if so how?*

E.6	**Do you have experience with the aircraft manufacturer requesting changes to an engine that could result in the engine becoming non-compliant with its type certificate?** ☐Yes (Please describe) ☐No Description: *Please give examples. What were the consequences? What should be done to avoid this situation in future?*

E.7	**Do you have experience with either new technologies or certification approaches introduced at engine or aircraft level that affected the certification of the other product and were not recognised and resolved sufficiently early in the process?** ☐Yes (Please describe) ☐No Description: *Please give examples. What were the consequences? What were the root causes? What should be done to avoid similar occurrence in future?*

Group F	The following questions ask about your experience related to **technical** issues

F.1	**Do you have experience where engine installation assumptions and aircraft interface assumptions were found to be incomplete or inadequate, or not communicated at the right time?** ☐Yes (Please describe) ☐No Description: *Please give examples. What were the consequences? What were the root causes? What changes are needed to prevent similar occurrences?*

F.2	**Do you have experience where post engine certification design changes were needed for aircraft compliance to address engine non-compliance?**

	☐Yes (Please describe) ☐No Description: *Please give examples. What were the consequences? What were the root causes? What should be done to avoid similar occurrences?*

F.3	**Do you have experience where post engine certification design changes were needed for aircraft compliance to address airplane certification requirements?** ☐Yes (Please describe) ☐No Description: *Please give examples. What were the consequences? What were the root causes? What should be done to avoid similar occurrences?*

Group G	The following questions ask about your experience related to **general** issues

G.1	**What should we expect from a certificated engine (refer to background section for additional context)?** *This question covers the expectations, given today's regulations, and what you think would be optimum if regulations were changed to accommodate it. Please provide the rationale for your response.*

G.2	**Refer to your answer to question G.1 above; is the current system delivering this?** *Please provide the rationale for your response.*

G.3	**What is working well, considering all aspects of achieving engine and aircraft certification where there are interfaces between the two?** *Please provide a rationale for your response.*

G.4	**What is not working so well, considering all aspects of achieving engine and aircraft certification where there are interfaces between the two?** *Please provide a rationale for your response.*

G.5	**Do you have any other comments that you wish to make?**

Group H	The following requests your opinion regarding several statements about the **future**

Please provide the rationale for your answer.

H.1	**Ideally, a certificated engine should be capable of being installed in the intended application without design changes after certification** ☐ Agree ☐ Partially agree ☐ Neither disagree nor agree ☐ Partially Disagree ☐ Disagree Rationale:

H.2	**It is best if compliance demonstrations which can be made at engine level are made during the engine certification.** ☐ Agree ☐ Partially agree ☐ Neither disagree nor agree ☐ Partially Disagree ☐ Disagree Rationale:

H.3	**There would be advantages to making some engine compliance showings/findings following flight test on the intended aircraft. If you agree please list the advantages.** ☐ Agree ☐ Partially agree ☐ Neither disagree nor agree ☐ Partially Disagree ☐ Disagree Rationale:

H.4	**When the same compliance findings are required for both engine and aircraft compliance, regulators should ensure the applicable rules, guidance and policy is completely harmonized between engine and aircraft.** ☐ Agree ☐ Partially agree ☐ Neither disagree nor agree ☐ Partially Disagree ☐ Disagree Rationale:

H.5	**All certification requirements affecting the engine design should be contained in CS-E / FAR 33.** ☐ Agree ☐ Partially agree ☐ Neither disagree nor agree ☐ Partially Disagree ☐ Disagree Rationale:

H.6	**Having an engine type certificate is beneficial.** ☐ Agree ☐ Partially agree ☐ Neither disagree nor agree ☐ Partially Disagree ☐ Disagree

	If you answered "partially agree" "neither disagree nor agree" or "disagree" would you advocate moving from today's established system with an engine and an aircraft type certificate? Rationale:

H.7	**When a compliance demonstration requires aircraft data to show engine compliance, final compliance shall always be at aircraft level.** ☐ Agree ☐ Partially agree ☐ Neither disagree nor agree ☐ Partially Disagree ☐ Disagree Rationale:

Group I	**Closing Questions**

I.1	**Are you industry or authority (engine or aircraft manufacturer)? Check only one.** ☐ Industry - Engine ☐ Industry - Aircraft ☐ Agency - Engine ☐ Agency - Aircraft

I.2	**Taking a view on the development of large transport aircraft and engines over the next 10 to 20 years, are there any aspects of the certification process, that impact the airframe/engine interface that you think should be changed now to better prepare authorities and industry for future products? If so what are they, and why and how should they be changed? Whether or not you think immediate changes are needed, how do you think the engine and airframe certification process should evolve over the next 20 years?** Description:

I.3	**If you have additional thoughts on this subject that were not covered by the questions in the survey, please provide them in the area**

	Description:

--- End of Survey ---

Attachment – Issue Examples

- Part 25 requirement / policy / guidance material imposed on the engine on top of CS E (e.g., ARP4754, COTS, EWIS)
- Safety assessment; HAZ engine vs CAT aircraft regulations – Single failure treatment different at engine & aircraft level (e.g., Overspeed, thrust control malfunction)
- Additional engine testing requested during aircraft certification (e.g., fire protection, icing, cross-wind)
- Late availability of accepted engine ICA/integration of engine ICA into aircraft manuals
- Engine reliability issues interfering with aircraft flight test or even aircraft certification
- Conflicting engine and aircraft certification requirements
- Insufficient guidance on propulsion system test guidance (e.g., thrust reverser conformity)
- Different interpretation of identical requirement at engine and aircraft level
- Overlapping/duplicate review of data at engine and aircraft level (e.g., engine software)
- Discrepancy between engine and aircraft requirements/unclear interface requirements (e.g., firewall structure test requirements)
- Engine certification granted relying on unrealistic conditions and/or limitations preventing normal aircraft certification—engine design change required to allow ‘normal’ operation

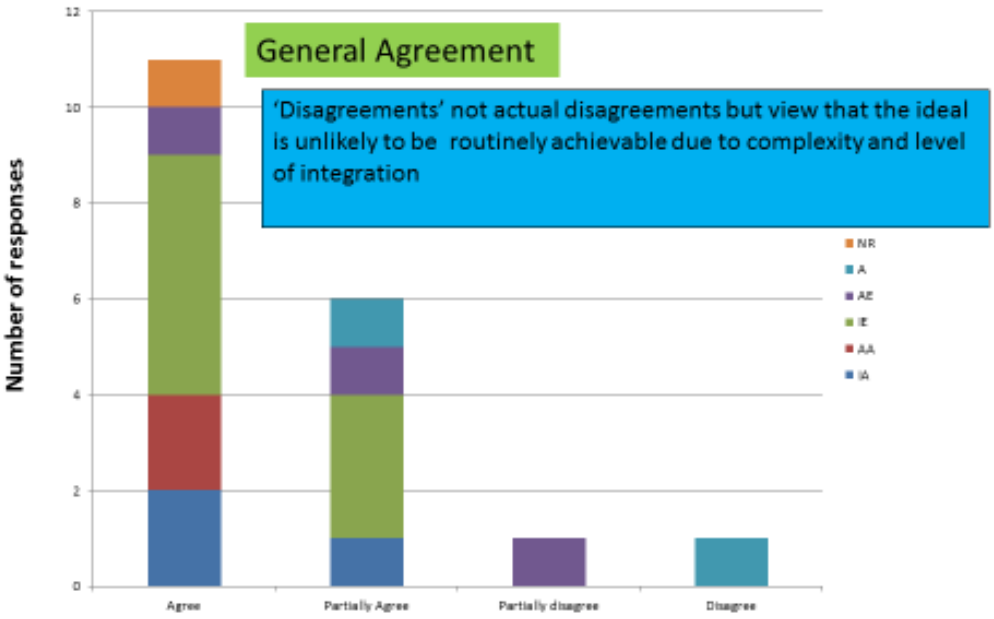
Survey Results

Analysis of Responses to Section H of the Questionnaire

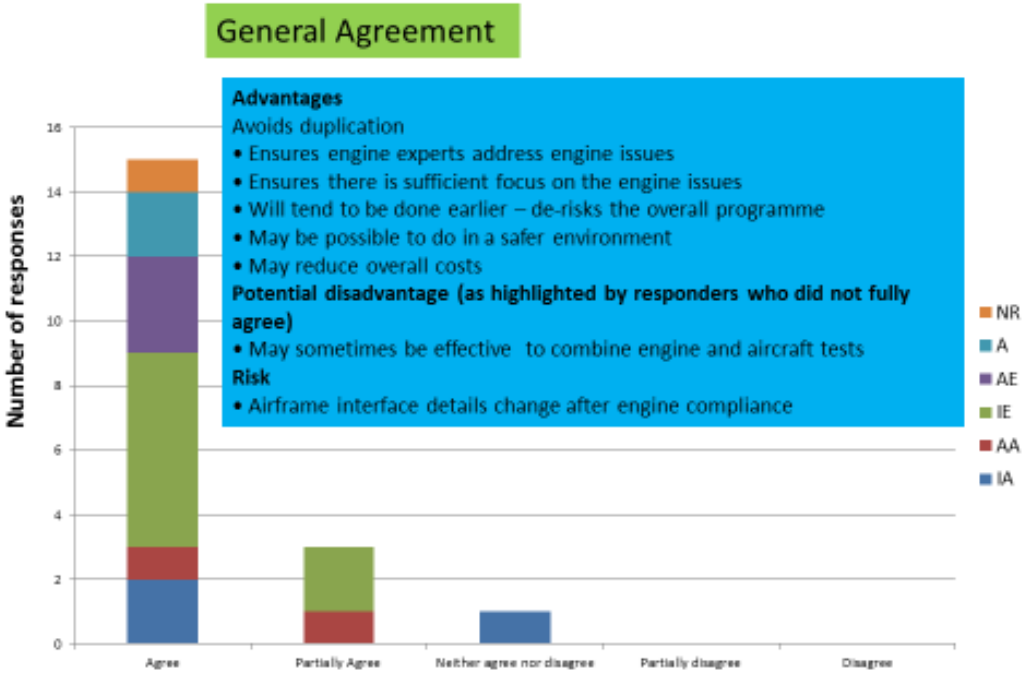
Legend for presentation on the evaluation of Section H

- NR **Respondent did not identify if agency or industry**
- A **Agency response (Engine and Airframe experts combined)**
- AE **Agency response – Engine Experts**
- IE **Industry response – Engine OEMs**
- AA **Agency response – Aircraft Experts**
- IA **Industry response – Aircraft Experts**

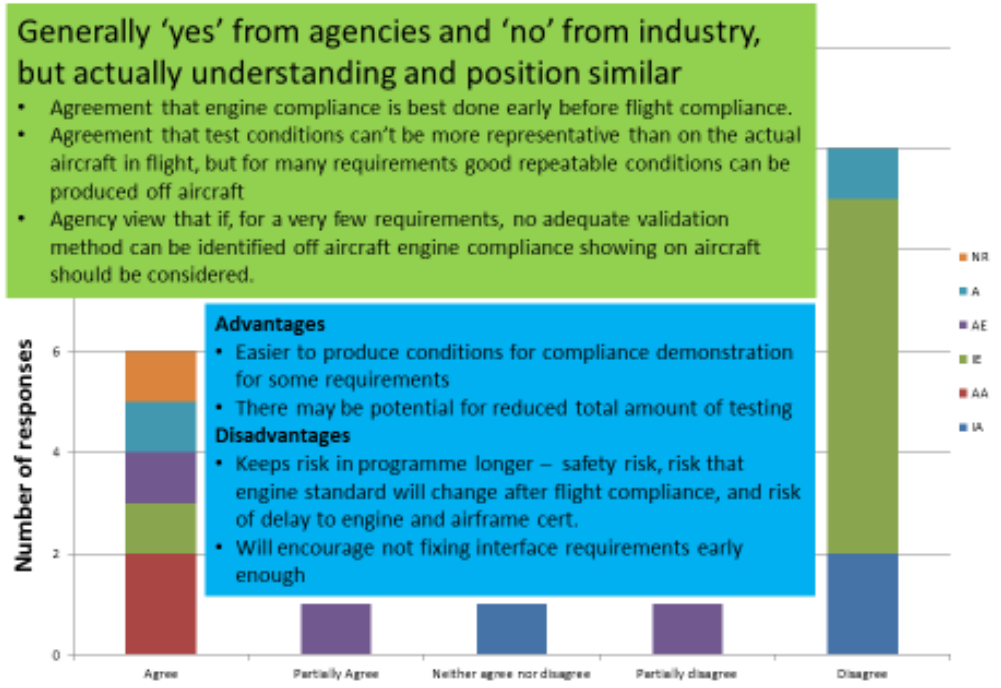
H1: Ideally, a certificated engine should be capable of being installed in the intended application without design changes after certification



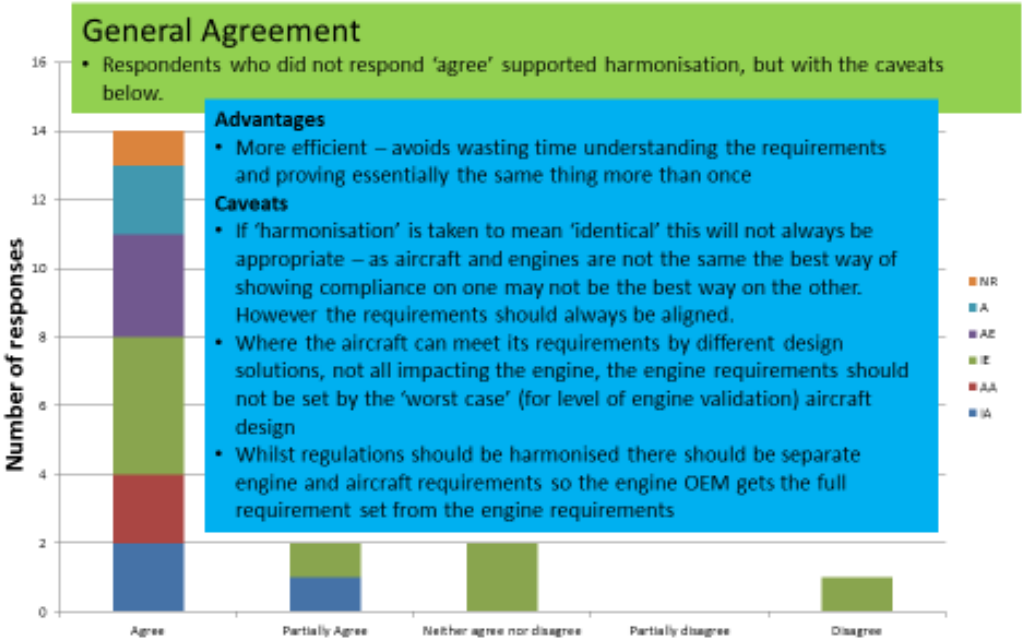
H2: It is best if compliance demonstrations which can be made at engine level are made during the engine certification.



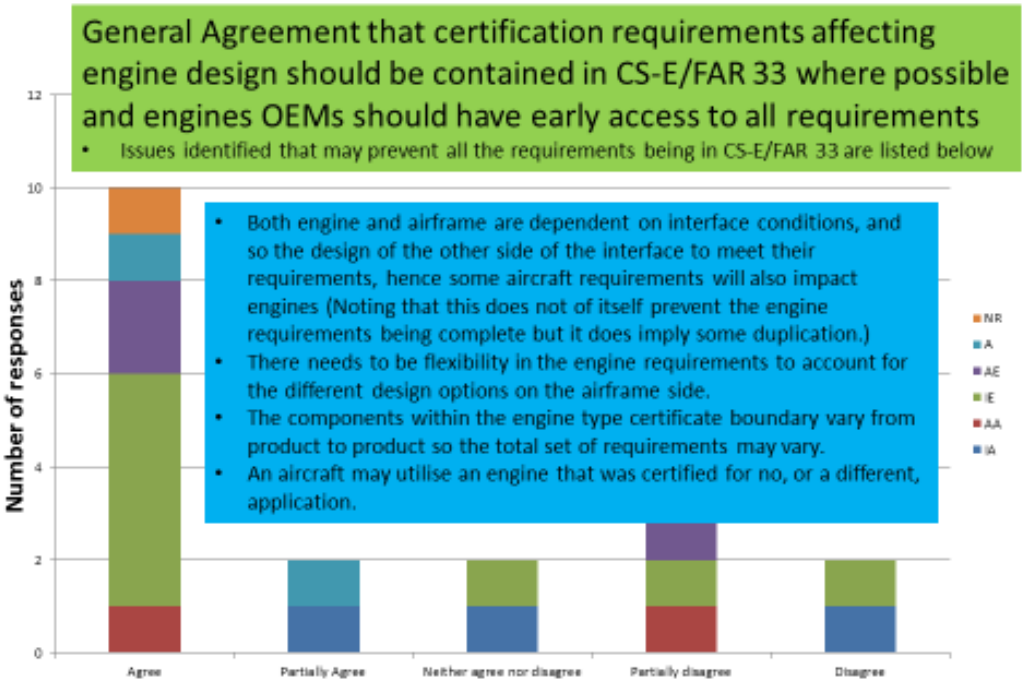
H3: There would be advantages to making some engine compliance showings/findings following flight test on the intended aircraft.



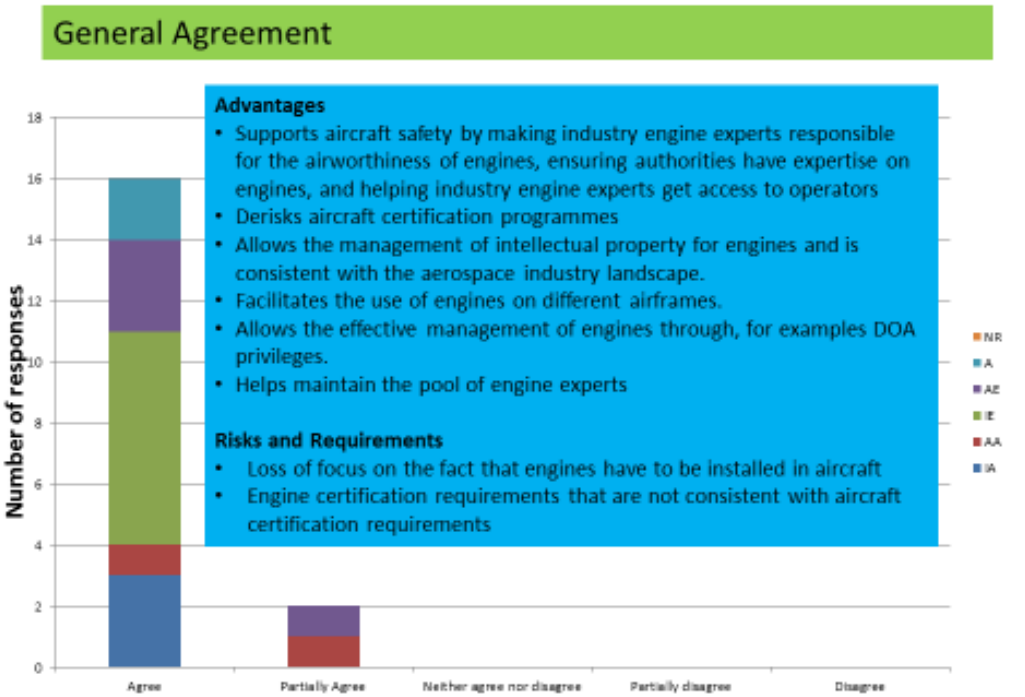
H4: When the same compliance findings are required for both engine and aircraft compliance, regulators should ensure the applicable rules, guidance and policy is completely harmonized between engine and aircraft.



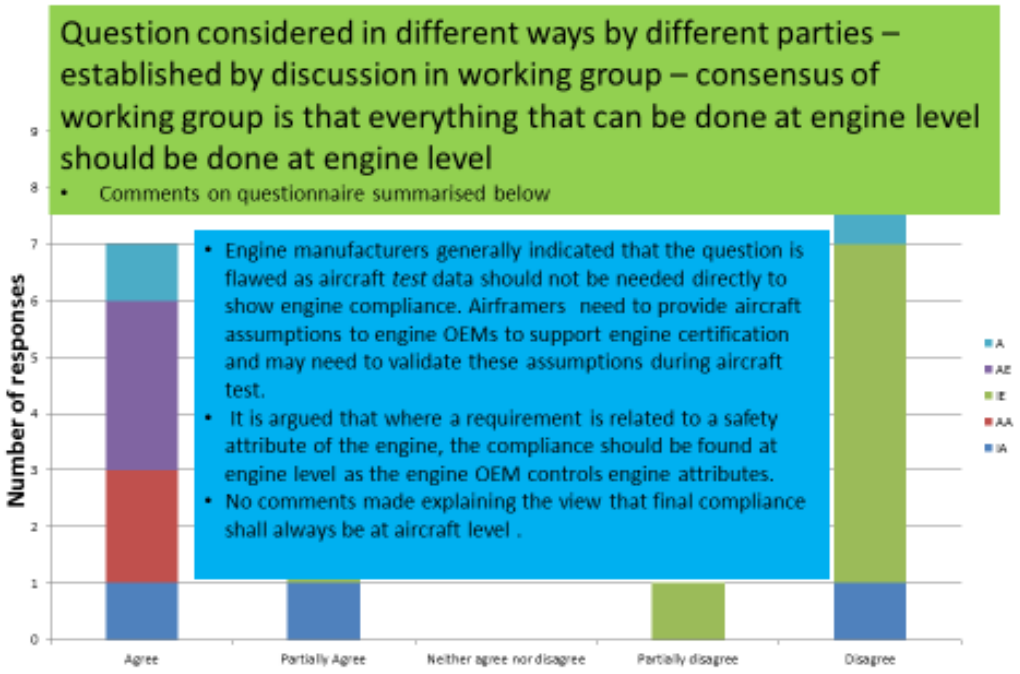
H5: All certification requirements affecting the engine design should be contained in CS-E / FAR 33.



H6: Having an engine type certificate is beneficial



H7: When a compliance demonstration requires aircraft data to show engine compliance, final compliance shall always be at aircraft level.



Analysis of Responses to Sections G of the Questionnaire

Engine Certification – summary of key points

G1: What should we expect from a certified engine?

- That it is compliant with CS-E/FAR 33
- That it will operate safely within the defined limitations, and as required by the interface documents, and the ICA.
- That, where there is a need for the engine , being an aircraft system, to meet Part 25 requirements, these will have been demonstrated during engine certification for the identified engine/aircraft interface requirements (except for any Part 25 requirements that can only be demonstrated at total system level).
- .... And given the above an engine should not present issues to aircraft certification provided that the airframe interface conditions are as described in the interface documentation

G2: Is the current system delivering this?

- Largely yes, however...
  - The interface conditions are not always as defined and agreed for engine certification, resulting in additional testing and/or design change at engine or airframe level
  - Part 25/CS-25 and FAR 33/CS-E are not fully aligned so that an engine can be certified without meeting all necessary requirements that could be met at this stage
  - Engine design issues that impact the aircraft certification programme are not unknown

The spreadsheet below summarises the responses to the surveyquestions with Yes/No Answers .

No	Category	Question	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19
A1	communication and timing	Do you have experience where the engine/airframe interface requirements have been fixed later than would be optimum by the manufacturers, or where regulatory requirements on the engine and airframe are inconsistent and this has not been recognized at an early stage?	Y	Y	Y	Y	Y	Y	Y	Y	NR	Y	Y	Y	Y	Y	y	Y	Y	Y	Y
A2	communication and timing	Do you have experience where clear and timely communication between the engine manufacturer, aircraft manufacturer, engine airworthiness authority, and/or aircraft airworthiness authority did not occur?	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	y	N	Y	Y	Y
A3	communication and timing	Do you have experience of aircraft activities which resulted in changes to rules, specifications, guidance or standards mandated by CRI/issue paper where the engine was impacted and the engine community was not sufficiently involved, or vice versa?	N	N	Y	Y	Y	Y	Y	Y	NR	Y	Y	Y	Y	Y	y	N	Y	Y	Y
A4	communication and timing	Do you have experience where completion of engine instructions for continued airworthiness (ICA) was deferred until after engine type certification (TC) and this resulted in flight test or engine integration problems?	Y	Y	N	N	N	N	N	N	NR	N	N	N	N	N	y	N	N	N	N

No	Category	Question	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19
B1	duplication of work	Do you have experience where aircraft verification/testing which was carried out, either by decision of the aircraft manufacturer or because required by the authority, when verification of the requirements in question had already been completed at engine level?	NR	N	N	Y	N	Y	Y	N	NR	Y	N	Y	N	N	y	N	Y	Y	Y
B2	duplication of work	Do you have experience where some aspect of engine certification compliance has been reinvestigated during aircraft certification because of a proven or perceived lack of compliance, or because authorities at aircraft level wish to investigate directly?	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	N	N	Y	y	Y	Y	Y	Y
C1	gaps in requirements	Do you have experience where aircraft testing in the installed configuration was required, to address an area that is expected to be fully covered during engine certification? If yes, was the root cause	Y	Y	Y	N	Y	N	Y	N	NR	Y	N	N	N	N	y	Y	N	Y	Y
C2	gaps in requirements	Do you have experience of issues arising during aircraft certification that you might reasonably have expected not to occur with a certified engine?	Y	Y	Y	N	N	N	N	Y	NR	Y	N	Y	Y	Y	y	Y	Y	Y	Y
D1	process	Do you have experience of difficulties achieving timely identification, escalation and resolution of engine/aircraft interface issues including projects involving different engine and aircraft states of design?	N	N	Y	N	Y	N	Y	N	NR	N	Y	N	Y	N	y	N	Y	Y	Y

No	Category	Question	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19
D2	process	Do you have experience of industry finding it difficult to question/escalate decisions to apply aircraft certification requirements/policies to engines, or to question why an engine certification requirement doesn't adequately cover an aircraft certification requirement?	N	N	Y	N	N	N	N	Y	NR	Y	N	N	Y	Y	y	Y	Y	N	Y
D3	process	Do you have experience where lack of clear responsibilities/boundaries/best practice guidance led to late identification of issues and duplication of certification activity?	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y	N	N	N	y	N	Y	Y	Y
D4	process	Do you have experience where all data necessary for aircraft certification was not produced during engine certification or not included in engine installation manual?	N/A	Y	Y	N	N	N	N	N	NR	Y	N	N	Y	N	y	N	Y	Y	N
E1	rules and interpretation	Do you have experience of where aircraft/engine interface certification requirements were not clearly defined or not aligned sufficiently early in the certification programs?	N	N	Y	Y	Y	Y	Y	Y	NR	Y	Y	N	N	Y	y	N	Y	Y	Y
E2	rules and interpretation	Do you have experience with conflicting safety considerations in aircraft/engine certification requirements?	Y	N	N	N	N	N	N	N	NR	N	N	N	Y	N	y	N	Y	Y	Y
E3	rules and interpretation	Do you have experience with inconsistent application of existing aircraft and engine certification requirements, policies, or interpretations, including those found acceptable on prior certification programs?	Y	N	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	y	Y	Y	Y	Y

No	Category	Question	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19
E4	rules and interpretation	Do you have experience with introduction of new policy, requirements, or interpretations at aircraft level that affected the engine certification program after the engine certification basis was agreed and part way through the engine type investigation program?	Y	N	N	N	Y	Y	N	Y	NR	Y	N	N	Y	N	Y	Y	Y	Y	Y
E5	rules and interpretation	Do you have experience with aircraft certification requirements affecting the engine not reflected in engine certification requirements, or vice versa?	Y	Y	Y	Y	N	Y	Y	Y	NR	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
E6	rules and interpretation	Do you have experience with the aircraft manufacturer requesting changes to an engine that could result in the engine becoming non-compliant with its type certificate?	Y	N	N	N	Y	N	N	N	NR	Y	N	N	Y	N	Y	Y	Y	Y	N
E7	rules and interpretation	Do you have experience with either new technologies or certification approaches introduced at engine or aircraft level that affected the certification of the other product and were not recognised and resolved sufficiently early in the process?	Y	Y	Y	Y	N	Y	N	N	NR	Y	N	N	N	N	Y	N	Y	Y	Y
F1	technical	Do you have experience where engine installation assumptions and aircraft interface assumptions were found to be incomplete or inadequate, or not communicated at the right time?	Y	N	Y	N	Y	Y	Y	Y	NR	Y	Y	N	Y	Y	Y	N	Y	Y	N
F2	technical	Do you have experience where post engine certification design changes were needed for	Y	N	Y	N	N	N	Y	Y	NR	Y	N	Y	Y	N	N	N	Y	N	N

No	Category	Question	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19
		aircraft compliance to address engine non-compliance?																			
F3	technical	Do you have experience where post engine certification design changes were needed for aircraft compliance to address airplane certification requirements?	NR	N	Y	N	Y	N	N	Y	NR	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
G1	general	What should we expect from a certificated engine (refer to background section for additional context)?	R	R	R	R	R	R	R	R	NR	R	R	R	R	R	R	R	R	R	R
G2	general	Refer to your answer to question G.1 above; is the current system delivering this?	R	NR	R	R	R	R	R	R	NR	NR	R	R	R	R	R	R	R	R	R
G3	general	What is working well, considering all aspects of achieving engine and aircraft certification where there are interfaces between the two?	R	NR	R	R	R	R	R	R	NR	NR	R	R	R	NR	R	R	R	R	R
G4	general	What is not working so well, considering all aspects of achieving engine and aircraft certification where there are interfaces between the two?	R	NR	R	R	R	R	R	NR	NR	NR	R	NR	R	NR	Y	NR	R	R	R
G5	general	Do you have any other comments that you wish to make?	NR	NR	NR	R	R	R	R	NR	NR	NR	NR	NR	NR	NR	NR	NR	R	NR	NR
H1	future	Ideally, a certificated engine should be capable of being installed in the intended application without design changes after certification	A	PD	A	A	PD	A	A	PA	PA	A	A	D	PA	PA	A	PA	A	A	A

No	Category	Question	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19
H2	future	It is best if compliance demonstrations which can be made at engine level are made during the engine certification.	A	N	A	PA	A	PA	A	A	A	A	A	A	A	A	A	A	A	PA	A
H3	future	There would be advantages to making some engine compliance showings/findings following flight test on the intended aircraft. If you agree please list the advantages.	A	N	A	R	PA	D	D	D	PD	D	A	D	D	D	D	A	D	A	A
H4	future	When the same compliance findings are required for both engine and aircraft compliance, regulators should ensure the applicable rules, guidance and policy is completely harmonized between engine and aircraft.	A	A	A	N	A	N	PA	A	A	PA	A	A	A	A	A	A	D	A	A
H5	future	All certification requirements affecting the engine design should be contained in CS-E / FAR 33.	A	A	A	A	PD	A	A	A	A	D	PD	A	A	D	PA	PA	N	PD	A
H6	future	Having an engine type certificate is beneficial.	NR	A	A	A	PA	A	A	A	A	A	A	A	A	A	A	A	A	PA	A
H7	future	When a compliance demonstration requires aircraft data to show engine compliance, final compliance shall always be at aircraft level.	A	A	A	DA	A	D	D	PD	A	D	D	D	PA	D	PA	A	D	A	A
I1	closing	Are you industry or authority (engine or aircraft manufacturer)? Check only one.	I-A	I-A	A-A	I-E	A-E	I-E	I-E	I-E	A-E/A	I-A	I-E	A-E/A	I-E	I-E	I-A	A-E/A	I-E	A-A	A-E

No	Category	Question	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19
I2	closing	Taking a view on the development of large transport aircraft and engines over the next 10 to 20 years, are there any aspects of the certification process, that impact the airframe/engine interface that you think should be changed now to better prepare authorities and industry for future products? If so what are they, and why and how should they be changed? Whether or not you think immediate changes are needed, how do you think the engine and airframe certification process should evolve over the next 20 years?	NR	R	R	R	R	R	R	R	NR	NR	R	R	R	NR	R	NR	R	R	NR
I3	closing	If you have additional thoughts on this subject that were not covered by the questions in the survey, please provide them in the area	NR	R	R	NR	NR	NR	NR	NR	NR	NR	R	NR	NR	NR	NR	NR	NR	NR	NR

Abbreviation	Meaning
A	Agree
A-A	Agency-Aircraft
A-E	Agency-Engine
D	Disagree
I-A	Industry – Aircraft
I-E	Industry-Engine
N	No or Neither
NR	No Response
PA	Partially Agree
PD	Partially Disagree
R	Response
Y	Yes

Appendix E - Full list of recommendations

Legend:

Benefit: L… Low, M… Medium, H… High
Timing: S… Short, M… Medium, L… Long
Resources: L… Low, M… Medium, L… Long
Priority: 1 (High), 2 (Medium), 3 (Low)

No	Recommendation	Benefit	Timing	Resources	Priority
Conduct a certification program					
1.1	At the request of the applicant, conduct multiparty project reviews with engine/aircraft applicants and regulators early in a certification effort to list, detect, and resolve regulatory gaps, overlaps, and interdependencies, and repeat as necessary. Note: R.1.1 and R1.2 would typically only involve the primary certificating authorities of both products, but might be extended to more parties.	H	S	L	1
1.2	Develop authority internal processes to require aircraft and engine regulators to cross-communicate and resolve interface issues at the start of a program or immediately after they arise. Note: R.1.1 and R1.2 would typically only involve the primary certificating authorities of both products, but might be extended to more parties.	H	L	L	1
1.3	Develop an efficient process for engine/aircraft manufacturers to communicate conflicting requirements to the engine and aircraft authorities and to escalate, and resolve them.	H	S	M	1
1.4	Develop internal authority training and processes to drive cultural/behavioural change to ensure seamless integration and implementation of aircraft and engine regulations and guidance.	L	M	H	2
Understanding and developing the regulatory requirements					
2.1	Develop and document an authority-approach specifying the ground rules for developing regulations and guidance at the engine-and aircraft interface.	M	M	M	2

No	Recommendation	Benefit	Timing	Resources	Priority
2.2	Review engine interface requirements at the 14 CFR part 33, CS-E, 14 CFR part 25 and CS-25 levels for potential changes to decrease redundancy/gaps (reference Appendix C).	M	S	L	1
2.3	Review 14 CFR part 33 and 14 CFR part 25 policies and CS-E and CS-25 certification memoranda for potential changes to decrease redundancy/gaps.	M	M	M	2
2.4	Maintain an up to date regulatory and interpretations difference list between engine (14 CFR part 33 and CS-E) and aircraft (14 CFR part 25 and CS-25) requirements that is easily accessible to all stakeholders.	M	S	L	1
2.5	Create, maintain and publish a list on how aircraft requirements are met at engine level so that it can be easily reviewed by stakeholders to aid certification programs.	H	M	M	2
2.6	Revise relevant safety analysis policies to highlight the differences in engine and aircraft certification methodologies, and provide rationale for those differences.	L	M	M	3
2.7	Establish a forum and process for engine and aircraft airworthiness authorities and industry to review conflicts and gaps between engine (14 CFR part 33 and CS-E) and aircraft (14 CFR part 25 and CS-25) regulations to eliminate them and to proactively review regulatory change opportunities.	H	S	M	1
2.8	Publish policies/Certification memoranda or rule updates to formalize the regulatory approach to topics covered by generic issue papers and CRIs (e.g., issued on every current program) and make the required certification standard clearer.	H	M	H	1
Understanding if the engine/airframe certification interface is working effectively					
3.1	Monitor occurrence of interface issues during certification projects (e.g., number, frequency and severity), review and recommend changes to processes, regulations and/or policies if appropriate.	L	M	M	3
Address Specific Rule and Policy Gaps					

No	Recommendation	Benefit	Timing	Resources	Priority
4.1	Review 14 CFR part 33 and CS-E to determine how they support the functional and reliability flight test requirement of FAR 21.35(f)/Part 21.A.35(f). If needed, propose amendments to the relevant requirements.	M	M	L	2
4.2	Publish policy for 14 CFR part 33 and CS-E to address rapid restart/high power fuel cuts and quick windmill relight in 14 CFR part 33 and CS-E guidance and/or complete rulemaking as needed.	L	H	H	2
4.3	Revise 14 CFR part 33, CS-E, 14 CFR part 25 and CS-25 policies to ensure that rotor blade fragments that lie outside the compressor and turbine rotor case, as established during the engine certification, are given due considerations during aircraft certification, when appropriate.	M	L	H	2
4.4	Publish AC 25.1535-X to address ETOPS policy on acceptable methods of compliance, including type design changes and when flight testing is required. Address cases where §25.1535 is part of the aircraft certification basis but §33.201 is not in the installed engine certification basis. Coordinate 14 CFR part 33 with 14 CFR part 25 and revise 14 CFR part 33 policy as needed. EASA should consider publishing harmonized guidance.	H	M	H	1
4.5	Address if and when aircraft systems should be able to inhibit the operation of engine systems for preventing hazardous engine failure in the event of an engine loss of load. Determine what regulatory or policy/guidance changes would be needed to implement the recommendations and initiate the regulatory change process, taking note of discussions already held.	M	H	H	2
4.6	Define a harmonized set of requirements for fire protection and the verification of fire protection requirements. Provide recommendations within 6 months to address the current issues, and make recommendations in the longer term that, when implemented, would give a fully appropriate, consistent and implementable set of regulations and guidance on fire protection.	H	M	H	1

No	Recommendation	Benefit	Timing	Resources	Priority
4.7	Establish whether compliance with existing 14 CFR part 33 and CS-E regulations meets all 14 CFR part 25 and CS-25 EWIS requirements. If it does, formally document how this is achieved; if not, provide guidance at the engine and aircraft level on meeting EWIS requirements and secondly propose changes to 14 CFR part 33 and CS-E that would meet the 14 CFR part 25 and CS-25 EWIS requirements. Initiate regulatory change processes if needed.	M	M	M	2
4.8	Update AC 20-18B (Qualification Testing of Turbojet and Turbofan Engine Thrust Reversers) to clarify that aircraft regulatory requirements must still be met when the thrust reverser is included as part of the engine type certificate. EASA to produce new EASA thrust reverser AMC to cover this issue.	L	H	H	3
4.9	Consider expanding the EASA guidance in AMC E 10 (b) or AMC E 890 in line with AC 20-18B (Qualification Testing of Turbojet and Turbofan Engine Thrust Reversers).	M	M	M	2
4.10	Clarify the requirements at engine level – expected to be associated with the scope of engine control system – when an aircraft certification program is using ARP 4754 to support compliance with §25.1309. Consider adopting the existing EASA CRI. The FAA should update AC 20-174 and EASA should update the relevant AMC. Engine and aircraft policies should be consistent to avoid imposing additional requirements on the engine control system via the aircraft certification basis.	M	M	H	2
4.11	Review the icing requirements to see if improvements in guidance or application can be made to streamline the process across the interface. Initiate the regulatory change process to address any required improvement.	H	M	H	3
4.12	Resolve the discrepancy between certification and operational snow requirements.	M	L	H	2

No	Recommendation	Benefit	Timing	Resources	Priority
4.13	Review the 14 CFR part 33, CS-E, 14 CFR part 25 and CS-25 policies on flight deck indications/instrumentation to ensure they are consistent and up to date. Address any issues found. Replace the 14 CFR part 25 repetitive issue paper on fuel system contamination indication with a published policy.	M	M	M	2
Recommendations beyond the scope of the EACWG					
5.1	Review the operating regulations (e.g. 14 CFR part 121) vs 14 CFR part 33 / CS-E and 14 CFR part 25 / CS-25 to determine whether any other discrepancies exist between the certification and the operational regulations.	L	H	H	3
5.2	Consider the need for a similar activity to be conducted on other product types (propellers, General Aviation aircraft, rotorcraft) and APUs in a follow-on activity.	L	H	H	3
5.3	Coordinate with the Environmental Protection Agency (EPA) / International Civil Aviation Organization (ICAO) on how best to address fuel venting requirements/interpretation as a follow-on activity. Note: the potential outcome is a rule change to 14 CPR § 34.11 in recognition of a change in technology.	M	H	H	2