Response to comments on NPA-E-38

1 - Justification of the NPA

Current JAR-E 510 is titled "Failure analysis" and current FAR 33.75 is titled "Safety analysis".

JAR-E 510 currently requires a summary listing of all failures which result in major or hazardous effects, along with an estimate of the probability of occurrence of these effects. However, the hazardous effects are only listed in the advisory material of JAR-E 510 and the acceptable numerical occurrence rate is only defined in the ACJ. FAR 33.75 currently requires an assessment that any probable malfunction, failure, or improper operation will not lead to four specific hazards of undefined severity. The listed JAR-E hazardous effects are different from the listed FAR 33 specific hazards.

JAR-E 510 requires a list of assumptions contained within the failure analysis and the substantiation of those assumptions. Most of the JAR-E 510 assumptions are covered by other FAR 33 paragraphs. Both regulations require analysis to examine malfunctions and single and multiple failures; however, 33.75 also requires an examination of improper operation.~~FAR 33.75 and JAR-E 510 rules were significantly different, although both basically required a safety analysis of the engine design. FAR 33 called for a top-down approach whilst JAR-E 510 required a bottom-up approach (failure mode and effect analysis).~~

~~FAR 33.75 currently defines the Hazardous Engine Effects in the rule. They are listed in the advisory material of JAR-E 510. In addition, the considered effects were different in the two codes.~~

A harmonisation effort was initiated and this NPA-E-38 is the result of that activity. It contains rules almost identical to the new proposed FAR 33 rules and the advisory material has been developed in common. The basis of the harmonisation was JAR-E 510.

Consideration of errors in maintenance has been introduced since the lessons learned from service should be considered in order to avoid further events on new designs.

The current JAR-E 510 (e)(2) about MMEL has been deleted as not being relevant to certification rules for engines. There was no similar requirement in FAR 33. The approval of the MMEL and of the engine dispatch configuration is done at the aircraft level under another code. It is recognised that the safety analysis of JAR-E 510 may be used to support the definition of the engine dispatch configuration. However, this is not a necessary condition for the certification of the engine.

Consistency of these rules with the aircraft rules on the aircraft safety analysis was questioned. After debate, it was concluded that these proposals were adequate for the engine certification.

JAR-E 510 defines the engine-level failure conditions and presumed severity levels. Aircraft-level failure classifications are not directly applicable to engine assessments since

the aircraft may have features that could reduce or increase the consequences of an engine failure condition. Additionally, the same type-certificated engine may be used in a variety of installations, each with different aircraft-level failure classifications.

Since aircraft-level requirements for individual failure conditions may be more severe than the engine-level requirements due to installation effects, there should be early co-ordination between the engine manufacturer and the aircraft manufacturer to ensure that the engine may be installed in the aircraft.

Therefore, JAR-E (and FAR 33 in the new harmonised rules) defines « unwanted » engine effects, requires an estimate of the occurrence rates for these effects and defines acceptable rates (pass / fail criteria) for the engine certification. This was the previous way of applying JAR-E 510 and its associated ACJ.

2 - Economic impact analysis

Both FAR 33.75 and JAR-E 510 required an engine safety analysis. The proposals of this NPA will formalise a common approach for engine certification.

The proposals of this NPA are based on the current JAR-E 510 rules and do not fundamentally change the requirements as they where interpreted by means of ACJ E 510. Clarification of rules is provided with a clear separation of what is relevant to the rule itself and what is relevant to advisory material.

Therefore, there should not be an adverse economic impact.

3 - Comments received during the circulation of the NPA

Comments were received from the following organisations :

- Authorities of Austria, Denmark, France, Germany, Malta, United Kingdom and USA
- Airbus UK, SBAC (UK), Turboméca
- JAA Engine Study Group

4 - Response to comments

Six commenters either accepted, or supported, or provided no comment on the proposal.

One commenter complained against the format. This comment was noted.

General comments

One commenter suggested that the proposed JAR-E 510 was not complete because it did not require, as a formal outcome of the safety analysis, an identification of the critical parts. This commenter proposed to add to paragraph (a)(2) the following : « Any Critical Part

shall be clearly identified in this summary ». This comment was noted and agreed in principle. Although, proposed JAR-E 510 (c) implicitly covers this point, without direct reference to critical parts and to JAR-E 515 : further clarification could be provided by the harmonisation activity currently undertaken on subject of critical parts (NPA-E-44).

One commenter suggested that there was a need to check throughout JAR-E the use of the words « hazard » or « hazardous » with regard to the new definition proposed by NPA-E-38 of the « Hazardous Engine Effect », for consistency of vocabulary. This was agreed and registered as a future ESG action.

One commenter suggested to re-write the final paragraph of the justification in present tense. This was agreed.

One commenter requested a better justification for the deletion of reference to MMEL in JAR-E 510 and questioned the means used to approve the engine dispatch configuration. This was agreed and the justification was improved. It is to be noted that the engine certification does not necessarily result in an engine « dispatchability report ». The safety analysis of JAR-E 510 may be used to support the definition of the engine dispatch configuration.

Comments on JAR-E 510

One commenter requested a clearer definition of Minor, Major, Hazardous engine effects and considered that if they are not equivalent to those used in JAR 25.1309 this should be clearly stated at the beginning. The comment was not accepted. The definitions are in proposed JAR-E 510 (g) and it is considered that they are clear and appropriate for engine certification.

JAR-E 510(a)(1)

One commenter proposed to modify the paragraph to read as follows :
« *An analysis of the Engine, including the control system, shall be carried out in order to assess the likely consequence of all failures that can ~~reasonably~~ be expected to occur and provide a significant contribution in relation to the probability targets. This analysis must take account of.....* ». This commenter argued that 'Reasonably' is not a good guide for which failures need to be considered. This commenter added that it is the probability in relation to the level of Effect which is important, e.g. if it is 10^{-12} per Engine flight hour then it is not significant and does not warrant further consideration but if it is 10^{-8} for a Hazardous Engine Effect it is significant and needs to be considered. The comment was not accepted : the proposed wording is unchanged from current JAR-E 510.

One commenter proposed to modify the paragraph (i) to read as follows :
« *Aircraft-level devices and procedures assumed to be associated with a typical installation. Such assumptions must be stated in the analysis. It is recommended that the AMJ to JAR 25 1309 be read to put the engine analysis into context and to gain an understanding of the aircraft level analysis requirements.* » This comment was not

accepted. Such recommendation is not relevant to a rule. Furthermore, AMJ 25.1309 is referenced in paragraph (6) of ACJ E 510.

JAR-E 510 (a)(2)
One commenter suggested that failure data for all categories of failure should be provided because the effects on the aircraft of a Minor Engine Effect may be much more severe. This comment was not accepted. JAR-E 510 (a)(2) is related to information provided by the engine manufacturer to the engine authority. The request of the commenter was related to information provided by the engine manufacturer to the aircraft manufacturer outside engine certification.

One commenter proposed to modify the paragraph to read as follows :
« *This summary is produced to enable the airframe manufacturer to assess the hazard and probabilities from engine failures which could have hazardous or catastrophic effects at the aircraft level.* » This comment was not accepted. This summary is produced to enable the engine authority to certify the engine.

JAR-E 510 (a)(3) and (a)(4)

One commenter considered that if a Hazardous Engine Effect is predicted to occur at a rate of 10-7 per Engine flight hour, it would not be acceptable to JAR 25.1309 on a multi-~~engined~~engine aircraft. This commenter stated that the aircraft has to achieve 10-7 per aircraft hour and noted that a four-~~engined~~engine aircraft would achieve 4 x 10-7 which is not meeting JAR 25.1309 requirements. He requested to amend the wording to reflect the overall aircraft requirements of JAR 25.1309. This comment was not accepted. The commenter was addressing aircraft certification issues which are not pertinent to engine certification to JAR-E. This issue is addressed in the proposed paragraph (3)(a) of ACJ E 510.

One commenter proposed to modify the paragraph (a)(3) to read as follows :
« *It shall be shown that Hazardous Engine Effects are predicted to occur at a rate not in excess of that defined as Extremely Remote (upper probability limit of ~~range from~~ 10^{-7} ~~to~~ 10^{-9} per Engine flight hour). The estimated probability for individual failures may be insufficiently precise to enable the total rate for Hazardous Engine Effects to be assessed. For Engine certification, it is acceptable to consider that the intent of this paragraph is achieved if the probability of a Hazardous Engine Effect arising from an individual failure can be predicted to be not greater than 10^{-8} per Engine flight hour. This can only be accepted after good engineering and best practices have been applied. It will also be accepted that, in dealing with probabilities of this low order of magnitude, absolute proof is not possible and reliance must be placed on engineering judgement and previous experience. ~~combined with sound design and test philosophies.~~* ». This commenter argued that it is not a range that should be stated, but the level which should not be exceeded. And added that it must not be seen for the numerical analysis to dominate during design and that it is needed to guide the designer and demonstrate an acceptable design but good design and test practices must always be applied first. The first part of the comment was understood but not retained as the proposed definition is consistent with JAR-1. The intent of the second part of the comment was acknowledged and the sentence was moved to the ACJ.

One commenter proposed to modify the paragraph (a)(4) to read as follows :
« *It shall be shown that Major Engine Effects are predicted to occur at a rate not in excess of that defined as Remote (probability less than ~~range from~~ 10^{-5} ~~to 10^{-7}~~ per engine flight hour)* ». See response above.

JAR-E 510 (e)(1)

One commenter requested to add the sentence : « Those related to Hazardous effects must be contained in the Airworthiness Limitation Section of the Instructions for Continued Airworthiness ». The intent of the comment was accepted. A reference to the instructions for continued airworthiness of JAR-E 25 was added.

JAR-E 510(f)(2)

One commenter stated that the words "manual and automatic controls" in the harmonised rule have been replaced with "aircraft-supplied data or power" and disagreed with this change. This commenter thought that it introduced confusion into what was previously a precisely-defined term and stated that the use of "manual and automatic controls" clearly indicated that the desired aspect under consideration was failure or malfunction of the control system, whether automatic or manually implemented. This commenter did not accept that "aircraft-supplied data or power" necessarily ~~refered~~referred to controls because controls imply a function, when data and power imply an input or output. This comment was not accepted. The ESG disagreed with the statement that "manual and automatic controls" is a precisely defined term. The word “control” is used with various different meanings in various JAR codes, including the aircraft throttles. In trying to define the word “controls”, the wording “engine control system” was considered. This was not accepted because the engine control system is part of the engine type design and is anyhow subject to this safety analysis (see JAR-E 510 (a)(1)). It was felt more appropriate to highlight some less obvious interface with the aircraft such as aircraft supplied data or power.

JAR-E 510 (g)

One commenter suggested to make clear that complete loss of thrust from an engine is minor on a multi-~~-engined~~engine aircraft. The comment was noted. The wording of JAR-E 510 (g) is considered as being clear enough.

One commenter considered that partial or complete loss of power from the engine could not be considered as a Minor event in a single-~~engined~~engine rotorcraft. He considered that JAR-E 510 (g)(1) was not consistent with JAR-E 510 (a)(1)(i) (need to take account of aircraft level procedures) and with paragraph (2) of ACJ E 510 (where it is stated that the ultimate objective is to ensure that the risk to the aircraft from all engine failure conditions is within an acceptable range). He added that a range of 10^{-3} to 10^{-5} per hour for engine failure would not be consistent with the hazardous consequences of an engine failure in a single-engined rotorcraft and would prevent certification of the aircraft. This argument was already known and understood. It should be noted that the world-wide fleets of engines, from all manufacturers, have an engine in-flight shut-down rate in that 10^{-3} to 10^{-5} per hour range, with some engines marginally entering the « remote » range (5. 10^{-6} per hour in-flight shut-down rate for all causes). Therefore, the request from the commenter would not

be consistent with what was accepted for all aircraft currently in service. Paragraph (3)(a) of ACJ E 510 addresses the classification of effects of engine failures at the aircraft level.

One commenter proposed to delete the words « For compliance with JAR-E » and in (g)(2) the word « inadvertent » as being superfluous. This was not accepted. The words « For compliance with JAR-E » are important to make clear that these definitions may not be appropriate for aircraft certification and therefore are limited to engine certification. The word "inadvertent" was retained in order to distinguish from those instances where engine separation would be intended under some circumstances.

One commenter asked if a significant loss of thrust or a total loss of thrust was a hazardous engine effect. This commenter noted that some of the examples in (g)(2) would result in total loss of thrust and requested clarification. The comment was noted. The total loss of thrust on its own is, for engine certification, a minor engine effect (see JAR-E 510 (g)(1)). The examples in (g)(2) are effects considered as hazardous by themselves, regardless of the degree of loss of thrust.

Comments on ACJ E 510

One commenter noted that the proposed ACJ used twice the wording « critical component » and considered that this was not consistent with European policy which refers to « critical parts ». This was agreed and text was accordingly changed.

One commenter suggested that the ACJ should state that the failure rates should not be computed considering the extreme operating conditions but considering operating conditions representative of the average fleet. This comment was accepted and paragraph (2) of ACJ was modified accordingly.

Paragraph (1)

One commenter proposed to modify the last sub-paragraph to read as follows :
« *Examples of methodologies are Fault Tree Analysis (FTA), Failure Mode and Effects Analysis (FMEA), Common Cause Analysis and Markov Analysis* ». This commenter considered that Common Cause Analysis has been shown to be a valuable method to identify failure conditions which no other analysis can, for example where a hot air leak can disrupt a system and also the warning indication means. The comment was noted. The ACJ quotes only examples of the most widely used methodologies.

Paragraph (2)

One commenter proposed to modify the paragraph to read as follows :
« *The ultimate objective of a safety analysis is to ensure and demonstrate that the risk to the aircraft from all engine failure conditions is ~~within~~ below an acceptable level ~~range~~. The basis is the concept that an acceptable overall engine design risk is achievable by ~~managing~~ designing the individual major and hazardous engine risks to acceptable levels. This concept emphasises reducing the likelihood or probability of an event proportionally with the severity of its effects. The safety analysis should support the engine design goals such that there would not be Major or Hazardous Engine Effects that exceed the required*

probability of occurrence as a result of engine failure modes ». The addition of the word "demonstrated" was not accepted because it was considered not necessary and the intent was adequately covered by the term "to ensure". The intent of wording "below an acceptable level" was accepted but alternative wording was introduced. The word "designing" was not accepted because we do not design a risk.

Paragraph (3)(a)

The 3rd sub-paragraph states : "*Since aircraft-level requirements for individual failure conditions may be more severe than the engine-level requirements, due to installation effects, there should be early co-ordination between the engine manufacturer and the aircraft manufacturer to ensure engine and aircraft compatibility."* One commenter suggested that the underlined clause should be removed from the paragraph and was of the opinion that the removal of the clause does not materially affect the meaning of the paragraph. This was agreed.

One commenter proposed to modify the last sub-paragraph to read as follows :
« *Since aircraft-level requirements for individual failure conditions may be more severe than the engine-level requirements, due to specific aircraft installation effects, there should be early co-ordination between the engine manufacturer and the aircraft manufacturer to ensure engine and aircraft compatibility* ». This was not accepted on the basis of the comment above.

Paragraph (3)(c)

The 4th paragraph states : "*In such cases, for engine certification, the applicant will assume a failure rate for these aircraft components. A failure rate of zero would be an acceptable assumption.…".* One commenter did not accept this addition (as underlined) to the safety analysis guidance. This commenter argued that the section of the rule to which the guidance applies addresses the assumption of aircraft-level devices, etc., that may mitigate or reduce the probability of hazardous engine events occurring - for example, the assumed presence of a fire-suppression system (see paragraph 1 of this ACJ). He considered that if a failure rate of zero is assumed for these components, the applicant is then exempted by the guidance for any required failure rate of the engine-level components, since multiplying any number by zero will yield an overall hazardous engine event rate of zero! This commenter considered that is clearly not the intent of the rule and that the allowance for aircraft-level protection is not meant to represent complete exoneration for engine-level requirements.
The same commenter added that JAR-E 510 (d) states : "*If reliance is placed on a safety system to prevent a failure progressing to cause Hazardous Engine Effects, the possibility of a safety system failure in combination with a basic Engine failure shall be included in the analysis*." And so considered that allowing a failure rate of zero clearly violates the rule.
The comment was agreed and the sentence was removed.

Paragraph (3)(c)

One commenter did not agree with the addition of the 3rd, 4th and 5th paragraphs to the harmonised ACJ, considering that these paragraphs circumvent the wording and intent of

the rule, for the same reasons described in the comment above. This comment was not understood. JAR-E 510 (f) requires consideration of some aircraft components which are not under the responsibility of the engine manufacturer. Therefore, some guidance material was necessary. These paragraphs are considered as being consistent with the rule.

Paragraph (3)(d)

One commenter suggested to change « i.e. » in § (3) (d) of ACJ E 510 into « e.g. » because in this text the use of « i.e. » in relation to critical parts would be wrong. This was agreed because the list which is provided gives only examples (and should be introduced by « e.g. ») and is not the list of the only possible cases (this would be the meaning of « i.e. »). This was agreed.

Paragraph (3)(d)(i)

One commenter proposed to modify the paragraph to read as follows :
« *The acceptable occurrence rate of Hazardous Engine Effects applies to each individual effect. The probability target of less than* 10^{-7} *per engine flight hour* ~~*to* 10^{-9} *range of probabilities*~~ *for each Hazardous Engine Effect applies to the summation of the probabilities of this Hazardous Engine Effect arising from individual failure modes or combinations of failure modes other than the failure of critical components (i.e., discs, hubs, spacers). For example, the total rate of occurrence of uncontrolled fires, obtained by adding up the individual failure modes and combination of failure modes leading to an uncontrolled fire, should not exceed* 10^{-7} *per engine flight hour The possible dormant period of failures should be included in the calculations of failure rates*.
Note, if each individual failure is less than 10^{-8} *per flight hour then summation is not required*.». This commenter argued that the target probability is the upper limit of the probability range and that 10^{-10} per engine flight hour would be acceptable. This comment was accepted with alternative wording.

One commenter understood that in (i) the second paragraph inferred that there should be no more than approximately ten sources of engine fire and requested clarification. Clarification can be found in JAR-E 510 (a)(3).

Paragraph (3)(d)(iii)

One commenter proposed to modify the first sub-paragraph to read as follows :
« *Uncontained debris cover a large spectrum of energy levels due to the various sizes and velocities of parts released in an engine failure. The engine has a containment structure which is designed to withstand the consequences of the release of a single blade (see JAR-E 810 (a)), and which is often adequate to contain additional released blades and static parts. The engine containment structure is not expected to contain major rotating parts should they fracture. Discs, hubs, impellers, large rotating seals, and other similar large rotating components should therefore always be considered to represent potential high-energy debris. Generally, multiple blades released, if uncontained, have dissipated most of their energy defeating the containment structure, and may typically be considered as low-energy debris (see also JAR-E 520 (c)(1)). There have been instances where the released blades have not penetrated the containment structure but have moved axially and penetrated the adjacent thinner casing and this should be considered during the analysis* ».

This was not accepted as being too specific and probably not adequate. The non-containment case described by the commenter is not sufficiently precise and, if implying high energy debris, could not be considered in the safety analysis because such engine would not comply with certification requirements. During discussion of this comment, it was realised that the sentence "Generally, …" would not be consistent with JAR-E 520 (c) (1) and was then removed as well as the following paragraph on fan blades : JAR-E 810 requires containment of one fan blade and JAR-E 520 (c) imposes low energy debris only if containment is defeated.

One commenter noted that the last line states that « Casings may therefore need to be considered as a potential for high energy debris » and considered this as a new requirement, not addressed in AC 20 128a. This commenter questioned the size of debris and trajectories to be assumed and requested clarification. The comment was noted. The intent of this NPA is not to check the adequacy of AC 20-128a. Because this is only a potential case, it is not possible to define size of debris and trajectories. This would need to be reviewed between aircraft and engine manufacturers during the aircraft certification.

Paragraph (3)(d)(iv)

Paragraph (3)(d)(iv) One commenter suggested to remove the words « caused by abnormal engine operation » as being superfluous. This was not accepted. Although it is obvious that engines are not designed to deliver toxic products and that JAR-E 510 is analysing failure conditions, it was considered that these words put useful emphasis on the intent.

One commenter proposed to modify the penultimate sub-paragraph to read as follows :
« *No assumptions of cabin air dilution or mixing should be made in this engine-level analysis; these can only be properly evaluated during aircraft certification. The intent of JAR-E 510 (g)(2)(ii) is to address the relative concentration of toxic products in the engine bleed air delivery. The Hazardous Engine Effect of toxic products relates to significant concentrations of toxic products, with "significant" defined as concentrations sufficient to incapacitate or cause permanent injury or subsequent death to persons exposed to those concentrations*. ». This commenter considered that it cannot be ignored that some effects may be seen later or there may be deterioration after the flight. This was not accepted. The intent was only to identify the immediate hazard during the flight as noted in first sentence of this paragraph. It is noted that there is a proposed harmonisation activity on cabin air quality which might address the concern expressed by the commenter.

Paragraph (3)(d)(v)

2nd bullet: One commenter proposed to change "*reverse propeller pitch in flight*" into "*the unintended movement of the propeller blades below the established minimum in-flight low-pitch position*" and considered that this new wording is consistent with the harmonised propeller safety analysis rule, and also represents the actual situation of reverse thrust from the propeller. This was agreed.

One commenter noted that uncommanded thrust reverse has resulted in Catastrophic failures and asked why it is being classified as only Hazardous. It was agreed that such events occurred but it is to be noted that JAR 25.933 requires the aircraft to be « capable of

continued safe flight and landing under any possible position of the thrust reverser ». Therefore this JAR-E 510 requirement is consistent with JAR-25 requirements.

Paragraph (3)(d)(vi)

One commenter stated that an uncontrolled fire was always judged as potentially catastrophic and questioned the means to assess the severity of the effects of such a fire. The comment was noted. "Fire" was already referenced in FAR 33.75. In this harmonised new rule, only uncontrolled fires are considered and determination of "catastrophic" effects can only be made at the aircraft level.

Paragraph (3)(d)(vii)

One commenter suggested to add guidance for the allowed timing to complete engine shutdown using aircraft-level protections in 2nd paragraph. Therefore, he proposed the addition of the underlined sentence to the ACJ paragraph as follows : "*It is acceptable to take account of aircraft-supplied equipment (fuel cut-off means, etc.) to protect against the 'complete inability' to shut down the engine. A time delay of several minutes, but not more than 5 minutes, is acceptable between initiation of the shutdown and termination of the combustion cycle. The inclusion of this item within the Hazardous Engine Effects should not preclude hardware or software intended to protect against inadvertent engine shutdown, including aircraft logic to mitigate against the inadvertent shutdown of all engines."* The comment was not accepted. The issue is to determine if there is a positive means to shut the engine down. The time delay is not relevant. The concern at the basis of this comment is not known : the proposed additional sentence may be seen as a new rule introduced by advisory material.

New paragraph (3)(d)(viii) ?

One commenter suggested to add guidance for the mount system failure and proposed the addition of the following paragraph to the ACJ : "*Failure of the engine mount system leading to engine separation is regarded as a Hazardous Engine Effect due to the potential for the separated engine to impact the aircraft and destroy critical systems or structure in flight. Service experience has shown that this may occur during separations at high engine thrust levels. Causes of engine mount system failure may include not only the high loads associated with severe engine damage, but also fatigue originating from handling damage or corrosion, or inadequate strength associated with manufacturing error*." This was not retained for ACJ E 510 because it is considered as a justification for the addition of this hazardous effect to JAR-E 510 (g)(2) and it was not providing additional guidance for complying with JAR-E 510. In addition, in this context, the source of the failure is not relevant.

Paragraph (3)(e)

One commenter considered that « per engine flight hour » should be used in place of « per flight hour ». This was agreed. This was corrected throughout the ACJ.

One commenter requested an explanation of the meaning of « loss of engine support load path integrity ». It was agreed that clarification was necessary~~. In the absence of an agreed interpretation, this example was deleted from the list.~~ : the text was improved.

One commenter proposed to modify the first two sub-paragraph s to read as follows :
« *Compliance with JAR-E 510 (a)(4) can be shown if the individual failures or combinations of failures resulting in Major Engine Effects have probabilities ~~in the range of~~ less than 10^{-5} ~~to 10^{-7}~~ per flight hour. No summation of probabilities of failure modes resulting in the same Major Engine Effect is required to show compliance with this rule.*

Major Engine Effects are likely to significantly increase crew workload, or reduce the safety margins. These items may not be applicable to all engines due to different design features and the list is not intended to be exhaustive. Furthermore, engine design variations may result in changes to the classification of these failure conditions. » The intent of these proposals was accepted with alternative wording.

Paragraph (3)(f)

One commenter noted that this should clearly refer to multi engine aircraft. This comment was not accepted. This paragraph is applicable to all installations.

Paragraph (3)(h),

One commenter proposed to modify the third sub-paragraph as follows :
« *Maintenance errors have contributed to hazardous or catastrophic effects at the aircraft level. Many of these events have arisen due to similar incorrect maintenance actions being performed on multiple engines during the same maintenance availability by one maintenance crew, and ~~are thus~~ although primarily an aircraft-level concern, obviating them or reducing their probability is primarily the responsibility of the engine designer.* »
The intent of the comment was accepted with alternative wording.

In 4th paragraph, 4th bullet: "Omitting to torque, under-torquing, over-torquing nuts, or failure to install." One commenter recommended that this item be deleted because the harmonisation group was unable to find any instances where this item led to an in-service event. This comment was not accepted. Over-torquing of nuts for example resulted in in-service events. The word “multiple” was deleted from the opening sentence since maintenance errors on single engine are equally as relevant.

Paragraph(4)(a)

One commenter proposed to delete words as follows : “Errors in operation of the engine have resulted in hazardous or catastrophic effects at the aircraft level ~~which otherwise would have been less serious~~””, considering that the deleted words did not add to the text. This comment lead to a complete review of this paragraph in order to clarify the intent. It was noted that the reduction of the likelihood of improper operation should be done at the aircraft level.

Paragraph (5)

One commenter made an observation on his own method when using a dependence diagram analysis. This was noted.

One commenter proposed to add a definition as follows :
- Common Cause Analysis. The acceptance of adequate probability of Failure Conditions is often derived from the assessment of multiple systems based on the assumption that failures are independent. Therefore, it is necessary to recognise that such independence may not exist in the practical sense and specific studies are necessary to ensure that independence can either be assured or deemed acceptable.

This commenter argued that this is a very important analysis which can find failures which can produce failure conditions that occur with a probability much higher than other analyses (the proposed words are from PNPA 25F-281 para f Appendix 1). This comment was not accepted. It was not possible to study a change to this NPA based on some unknown aircraft NPA (the commenter should have provided a copy of this P-NPA). Furthermore, the proposal is not a definition but is a description.

Paragraph (6)

In 4th bullet: "Society of Automotive Engineers (SAE), Document No. ARP 4761, "Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment". One commenter noted that this report has been issued as SP-1270 and suggested to replace "ARP 4761" with "SP-1270." After a check, it was noted that this was a wrong reference. The comment was then rejected. ~~This was accepted as an additional reference.~~

Paragraph(7)

One commenter, in first sub-paragraph, suggested to delete the sentence « *They should not be assumed to apply to the same or similar terms used in other requirements or ACJs* » on the basis that there should be common definitions to prevent misunderstanding, and that, where applicable, these definitions should be common with PNPA 25F 281. This was not accepted. This ACJ defines the terms necessary to understand and interpret the JAR-E rule. However, it is agreed that transfer of some of these definitions to JAR-1 could be studied under another NPA process.