

DISPOSITION OF INTERDIRECTORATE COMMENTS

Advisory Circular No. 25.362X, *Engine Failure Loads*

FAA Contact: Todd Martin todd.martin@faa.gov

No.	Comment	Requested Change	Disposition
Commenter: Narinder Luthra, ANM-120S			
1	AC 25.362(8)(c) does not seem to have an equivalent of AMC 25.362(7)(c)		The commenter is correct that AC 25.362(8)(c) includes more information than the corresponding AMC section. The subject paragraph in AMC 25.362 just refers to AMC 25-24. (That AMC is similar to, but not harmonized with the corresponding AC 25-24.) Rather than refer to AC 25-24, we chose to include the necessary information directly in AC 25.362 (paragraph 8c), as was originally agreed by ARAC.

No.	Comment	Requested Change	Disposition
Commenter: ANE-150			
1	The failure of a disk is a much more significant dynamic condition than a blade failure resulting in a much more severe dynamic condition with the potentially rapid deceleration rate of the engine.	Limiting the examples to bearing failure, bearing support failure and bird ingestion, users may not evaluate the full range of necessary conditions.	<p>The proposed 25.362 requirement, upon which the AC is based, requires that dynamic loads be evaluated for “failure of a blade, shaft, bearing or bearing support, or bird strike event.” It does not consider other rotor burst conditions such as a disk failure.</p> <p>A disk failure or other rotor burst condition can be a very traumatic event, and the transient loads potentially more severe than the highest energy single blade release. We believe that the ARAC group did not specify other rotor burst conditions because a rotor burst can have a number of different causes and result in a number of different failure conditions. It would therefore be very difficult to quantify for the loads analysis. The proposed fan blade out failure condition results in</p>

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			severe imbalance and is also tied to existing regulatory design and analysis conditions, such as 14 CFR 33.94. No change.
2	It is unclear whether a bearing support failure condition must be considered as a singular condition or as a secondary effect in conjunction with a significant primary failure.	Define whether the failure conditions involve secondary failures.	We believe the rule is clearly stated as noted above. No change.
3	As a singular condition, bird ingestion is not a failure condition per se and it is not a significant source of loading unless some secondary mechanical failure results.	Bird ingestion should not be considered a failure condition unless the intention is to show the aircraft can withstand the effects of bird ingestion when Part 33 compliance demonstrated mechanical damage to the engine.	Bird ingestion may result in structural failure and so should be considered. A statement will be added to the AC to clarify the requirement as follows: “When evaluating bird ingestion, the bird weight and quantity requirements specified in § 33.76 should be used.”

No.	Comment	Requested Change	Disposition
Commenter: Jeff Englert, ACE-116Wp			
1		Drop the word ‘engine’ from definition of Windmilling engine rotational speed. Engine is understood here, and then terminology would match previous definition use.	Agreed. The change is made in the definition and also where used later in the AC.

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Commenter: T.N. Baktha, ACE 118W			
1	Page 3 Line 3 TYPO “ necessary that the applicant perform a dynamic analysis”	Change to “applicant performs” or “applicants Perform”	Agreed. This section is rewritten.

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Commenter: RS, AIR-110			
1	Pg. 5, Sect. 8.b.: All models must be validated. Using words like “should”, “may”, “typically” convey that validation is a best practices and not a requirement. While some manufactures might have sophisticated analytical models, they did not get to that point without first going through a validation process somewhere in their history...therefore, the statement that “all models must be validated” remains true. Additionally, allowing the perception that validation is not always a must is counter productive when the field is trying to effectively manage certification safety with STC and PMA applicants.	Change vague wording in this section or specifically address that validation data must be presented even if it is old data (but still shown to be applicable).	Although the AC uses the term “should” in some cases, paragraph 8a does state that the dynamic model “must” be validated. Even though the term “must” is used, as explained in paragraph 2d, “Except in the explanations of what the regulations require, the term ‘must’ is used in this AC only in the sense of ensuring applicability of this particular method of compliance when the acceptable method of compliance described in this AC is used.” No change.
2	Pg. 5, Sect. 8.c.: Same as previous comment	Same as previous request	Same as previous disposition.

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Commenter: Chip Queitzsch, AIR-100			
1	<p>Sections 5.a, 5.c and 6.c of the draft AC ask the applicant to consider any failure condition that might cause significant transient loads. However, the rule only requires the applicant to consider a specified set of five failure conditions.</p> <p>Taken to the extreme, there could be an infinite number of hypothetical failures that might cause severe transient conditions. For example, consider a disk post failure or partial rim failure resulting in loss of two or more blades. The engine may continue to rotate for a limited time and depending on the specific stage, could result in a more severe condition than the conditions stipulated by the proposed rule. The problem is determining how an applicant might determine the worst case limiting condition for hypothetical or very rare difficult to quantify failure conditions. The five stipulated conditions represent a range of failures that have occurred multiple times in service and that can be reasonably quantified.</p>	<p>Revise the AC to focus on the five conditions specified in the rule.</p> <p>NOTE: If the intent of the wording in the draft AC is to protect against a new or novel design that may present unique failure modes not covered by those listed in the draft rule, then these concerns should be addressed via Issue Paper when the design is reviewed. If relying on future use of Issue Papers is not the preferred approach, then consider making the requested change, and also add a paragraph addressing future new/novel designs and advising the applicant to perform a risk of “other” more severe failure condition assessment.</p>	<p>Agreed. The referenced paragraphs are changed to focus on the specified failure conditions.</p> <p>Regarding the note: We agree, the intent of the AC (and the rule) is not to protect against a new or novel design, and these can be addressed by issue paper if needed.</p> <p>Commenter was consulted on the final proposed wording and agrees.</p>
2	<p>The draft rule identifies five failure conditions: blade loss, shaft failure, bearing failure, bearing support failure, and bird strike. The risks associated with the failures listed may be short duration ultimate load or fatigue related.</p>	<p>The blade loss section, 6.b, should include discussion of engines with fused bearing supports and the risk of partial blade failure (bird strike, FOD, etc) resulting in transient operation just below the fuse release load condition.</p>	<p>Agreed. The commenter was consulted and helped develop the final proposed wording.</p>

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		Section 6 should include loss of centerline in the list of concerns to be considered.	

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Commenter: Jim Kabbara, AIR-120			
1	Page 3. Section 6.b(1) "The applicant should determine loads on the engine mounts, pylon, and adjacent supporting airframe structure by dynamic analysis." Analysis needs to be validated.	Add at the end the sentence to read "The applicant should determine loads on the engine mounts, pylon, and adjacent supporting airframe structure by dynamic analysis that has been previously validated."	Validation of analysis is discussed later in the AC. The AC specifically states that the dynamic model must be validated. No change.
2	Page 4, Section 6.c - " Other failure conditions. As identified in paragraph 5c,, they should be evaluated by dynamic analysis to a similar standard and using similar considerations to those described in paragraph 6b. Analysis needs to be validated	Have the sentence to read " Other failure conditions. As identified in paragraph 5c,, they should be evaluated by <i>validated</i> dynamic analysis to a similar standard and using similar considerations to those described in paragraph 6b.	Validation of analysis is discussed later in the AC. The AC specifically states that the dynamic model must be validated. No change.

No.	Comment	Requested Change	Disposition
Commenter: Justin Carter			
1	Gust and Maneuver Load Requirements NPRM: It would strengthen the NPRM if it was explicitly listed which manufacturers have confirmed they already meet or	Explicitly list which manufacturers have confirmed they already meet or expect to meet these requirements	The NPRM already discusses the rulemaking process that was used to develop the proposed rules. Specifically, the NPRM discusses the role of the Aviation Rulemaking Advisory Committee,

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	expect to meet these requirements. This explicit list would confirm that all relevant manufacturers have had input.		which is a technical organization comprised of affected manufacturers. Their involvement is specifically outlined in the ARAC working group reports which are publically available. No change.
2	<p>Gust and Maneuver Load Requirements NPRM: According to Executive Order 13610, "agencies shall give priority, consistent with law, to those initiatives that <u>will produce significant quantifiable monetary savings or significant quantifiable reductions in paperwork burdens</u> while protecting public health, welfare, safety, and our environment." and "agencies shall give consideration <u>to the cumulative effects of their own regulations</u>"</p> <p>However it would appear a determination that this NPRM does not warrant at full evaluation has been made. It is stated that while "expected cost impact is ...minimal" it is not clear there are any safety benefits and savings are vaguely evaluated as "potential savings"(p24-28). A cost/benefit analysis would greatly strengthen the case for this harmonization rulemaking which could negatively impact regulatory innovation.</p>	Perform a cost/benefit analysis	<p>Since this is a harmonization project, it was determined that it is cost beneficial for reasons given in the NPRM. It was determined that a cost benefits study was therefore not necessary.</p> <p>No change.</p>
3	Gust and Maneuver Load Requirements NPRM: A concern not considered is that when currently certified aircraft that do not	Address additional concerns	This issue is addressed by the Changed Product Rule (CPR), § 21.101. When modifications are made, any new rule, including the rules proposed

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	currently meet these standards are modified, they could potentially be forced to step up to the new requirements. It is unclear what cost that would represent? It is conceivable that small entities might bear the burden of meeting the new requirements on modified aircraft, or this new regulation might serve as a barrier to market entry to small entities seeking to enter part 25 aircraft manufacturing.		by the Gust and Maneuver NPRM, must be evaluated per CPR. That cost was accounted for in the economic evaluation of the CPR rulemaking project. No change.

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	Commenter: Robert Grant, ASW-112		
1	Paragraph 5c: Examples of other engine structural failure conditions listed in the AC include the failure of shaft. Similar to a disk, hub, or spacer, the failure of a shaft is addressed by establishing a life limit based on cycles to crack initiation. The AC should address the reasons why the failure of a shaft is considered, but not the failure of a disk or hub. Certainly, a disk or hub failure will generate higher failure loads than the failure of a shaft. If the concern is that a shaft failure will unload the turbine rotor allowing the rotor blades and stator vanes to “clash and mash” then provide that explanation in the AC. A shaft failure may result in rapid deceleration and large loads throughout the	Explain why engine shaft failure is included in the list of engine structural failure conditions to be considered under 25.362.	A shaft failure is included because it is a foreseeable failure condition that could result in large loads for which the engine mounts and attachments should be designed. We believe this is adequately explained in the AC as follows: “Of all the applicable engine structural failure conditions, design and test experience have shown that the loss of a blade is likely to produce the most severe loads on the engine and airframe. ... However, service history shows examples of other severe engine structural failures where the engine thrust-producing capability was lost, and the engine experienced extensive internal damage. Examples are failure of a shaft, failure or loss of any bearing or bearing support, and bird ingestion.” A disk failure or other rotor burst condition can be

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	structure.		a very traumatic event, and the transient loads potentially more severe than the failure of a shaft. We believe that the ARAC group did not specify other rotor burst conditions because a rotor burst can have a number of different causes and result in a number of different failure conditions. It would therefore be very difficult to quantify for the loads analysis. No change.
2	Paragraph 5c: Examples of other engine structural failure conditions listed in the AC include bird ingestion. The bird ingestion failure condition should be limited to the bird sizes defined in Section 33.76.	Add a sentence that states: “Bird ingestion loads are based on the bird sizes defined in Section 33.76.”	Agreed. A statement will be added to the AC to clarify the requirement as follows, “When evaluating bird ingestion, the bird weight and quantity requirements specified in § 33.76 should be used.”
3	Paragraph 6b1: The AC states that engine loads should be determined for “the fan blade failure condition.” A fan blade failure may not be the limiting blade for all the engine mount and adjacent supporting structure.	Remove the word “fan” from the paragraph.	Agreed. The change is made.
4	Paragraph 8c2: This paragraph defines the upper end range of dynamic engine models as 3D finite element model. Programs like LS-DYNA are used to perform highly non-linear transient dynamic analysis using explicit time integration for blade-loss and birdstrike failure conditions. Since these failures are two of the engine failure	Change the last sentence of paragraph 8c2 to read: “...up to 3D finite element model with explicit time integration used to capture the physics of short duration impact events such as blade-loss and birdstrike”	Agreed. The change is made.

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	conditions stated in the AC, a better description of the high end of the analytical tools used by engine manufacturers in dynamic analysis is possible.		

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Commenter: AIR-510			
1	Global change. Incorrect format.	Delete “AC No. 25.362-X” for the header. Replace with “AC 25-362-X.”	Agreed. Change made.
2	Paragraph 1, 1st sentence, Page 1. Improper capitalization.	Remove the capitalization from the term “advisory circular.”	Agreed. Change made.
3	Footer Area, Page 1. Incorrect format.	Remove the page number 1 from the footer. Page numbers should not appear until the second page.	Agreed. Change made.
4	Paragraph 3, 3(a), & (b), Paragraph 4(b), (c) & (d), Pages 1 & 2. Incorrect punctuation.	Remove the colon after the end of each sentence.	Agreed. Change made.
5	Paragraph 4, Page 2. The term “advisory circular” has already been defined.	Use the acronym “AC”.	Agreed. Change made.
6	Page 6. Unnecessary language.	Delete the term “END.”	“END” will be deleted when the AC is ready for signature.
7	Page 6. Missing signature block.	Place the signature block five spaces under the last paragraph of the document.	This change will be made when the AC is ready for signature.