

Commenter	Comment	Disposition
	DISPOSITION OF PUBLIC COMMENTS ON DRAFT POLICY STATEMENT ANM-05-115-019, Interim Guidelines for Certification and Continued Airworthiness of Unbalanced Control Surfaces with Freeplay and Other Nonlinear Features	
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<p>FAA</p> <p>Paragraph a, page 3 of commenter's version Renumbered as Paragraph b, page 6</p> <p>Paragraph d, page 5 of commenter's version Incorporated in paragraph b, page 6</p> <p>Paragraph e, page 6 of commenter's version Renumbered as Paragraph d, page 8</p>	<p>The policy memo notes that LCO is a form of flutter, and yet allows it in some cases, in apparent conflict with the rule. The memo should clarify precisely if and when LCO may be accepted under the rule.</p>	<p>Former paragraph a (now switched with paragraph b) is rewritten to clarify that LCO is not itself unstable, and therefore could be accepted under the rule in some cases. Paragraph a, "Freeplay In Control Surface Design" is renamed "Acceptability of Freeplay-Induced LCO within the Design Envelope." The situations under which LCO may be accepted are outlined, including failure conditions.</p> <p>Paragraph d, "Failure Conditions," which addressed failure conditions, is incorporated into the new paragraph b, "Acceptability of Freeplay-Induced LCO within the Design Envelope."</p> <p>Paragraph e, "Instructions for Continued Airworthiness," is renumbered as paragraph d.</p>

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<p>FAA, continued</p> <p>Paragraph b, page 4 of commenter's version Renumbered as paragraph a, page 5</p> <p>Paragraph b, page 4 of commenter's version Renumbered as Paragraph a, page 5</p>	<p>The proposed policy includes reference to the freeplay limits provided in MIL-A-8870C, and states, "These may be used without additional substantiation." However, freeplay could still occur within these limits, so additional substantiation should be necessary in that case.</p>	<p>MIL-A-8870C freeplay limits "may be used without additional substantiation" is replaced with "Although not required, these limits are recommended because of their past successful use."</p> <p>The MilSpec limits (in paragraph b of the commenter's version) may also be used as described in paragraph a.</p>
<p>FAA, Airbus, Embraer</p> <p>Paragraph e(2), page 6, of commenter's version Renumbered as paragraph d(2), page 9</p>	<p>It is not necessary to make mass balance requirements CMRs or ALIs as defined in paragraph e, "Instructions for Continued Airworthiness."</p>	<p>The need to make mass balance requirements be CMRs or ALIs is removed from paragraph e(2) (and included in the renamed as paragraph d.). Mass balance procedures have always been part of the instructions for continued airworthiness required by § 25.1529. The mass balance limits are part of the type design and therefore FAA approval is required per § 21.97 to change these limits. There is no need to add additional requirements at this time.</p>

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<p data-bbox="170 269 279 297">Airbus</p> <p data-bbox="170 342 464 557">Paragraph e(2), page 6 of commenter's version Renumbered as paragraph d(3), page 9</p> <p data-bbox="170 967 426 1027">Airbus comments, continue</p>	<p data-bbox="489 342 1335 740"><u>Paragraph e, "Instructions for Continued Airworthiness"</u> Airbus proposes that maintenance instructions to check and manage control surface mass balance limits or freeplay limits be referred to as Candidate CMRs and are then handled according to the established CMR selection methodology as used for all other Candidate CMRs. This methodology will allow consideration to be given to tasks developed under the MRB process that, under defined circumstances, may be agreed as adequate to address regulatory concerns and thus avoid CMR status. Based on this, Airbus proposes that paragraph e(2) and (3) be modified as follows (changes are bolded):</p> <p data-bbox="489 760 1335 1414">(2) During certification, the applicant should establish static and/or dynamic balance limits for control surfaces that depend on mass balance for flutter prevention. The applicant should also establish mass balancing procedures that ensure the control surface will remain within these balance limits while in service. The applicant should give particular importance to maintaining the required mass balance following repaint, repair, or any other event that might alter the control surface mass properties. The applicant should prepare instructions for continued airworthiness that will include repetitive inspection /maintenance tasks to ensure the mass balance limits are retained throughout service life. Such tasks should be identified as Candidate Certification Maintenance Requirements (CMR). CMR selection and subsequent classification shall be established in accordance with AC 25.19 that provides guidance on the selection, documentation and control of the CMRs. If no appropriate MRB Report task and interval is identified, the applicant</p>	<p data-bbox="1335 342 1923 410">See the above disposition for paragraph e(2), renumbered as paragraph d(3).</p> <p data-bbox="1335 1036 1923 1109"><i>Note: Suggested changes by Airbus are in bold type.</i></p>

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<p>Airbus comments, continued</p> <p>Paragraph e(3), page 6 of commenter's version</p> <p>Renumbered as Paragraph d(3), page 9</p>	<p>should prepare instructions for continued airworthiness that include a task and interval to ensure the mass balance limits are retained and shall identify such a task as a CMR or Airworthiness Limitation Item (ALI). An FAA engineering approval will be required to change any certified balance requirements that are determined to warrant One Star CMR classification. The engineering approval must be by the Aircraft Certification Office (ACO) or the office of the Transport Airplane Directorate (TAD) having oversight responsibility for the relevant type certificate.</p> <p>(3) Freeplay in control surfaces that rely on the retention of stiffness for flutter prevention should be certified and managed throughout the life of the airplane. The applicant should account for wear and growth in freeplay between inspection intervals so the certified freeplay limits are not exceeded. The applicant should give special attention to areas of the control surfaces where the control system and supporting structure can wear, allowing freeplay and looseness to develop. The applicant should include the inspection intervals and related inspection procedures, which include freeplay limits and measurement procedures, in their instructions for continued airworthiness. The tasks and corresponding intervals to ensure that freeplay limits are retained should be identified as Candidate CMRs. The selection and classification of the CMR shall be established in accordance with AC 25.19 that provides guidance on the selection, documentation and control of the CMRs. If no appropriate MRB Report task and interval is identified, the applicant should create such a task and identify it as a CMR or ALI. An FAA engineering approval will be required to escalate any freeplay limits or inspection intervals that are determined to warrant One Star</p>	<p>Regarding paragraph e(3), renumbered as d(3), the FAA partially agrees with the comment. The paragraph is simplified and reference to existing practices emphasized. Freeplay limits are recommended to be Two Star CMRs.</p>

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	<p>CMR classification. The engineering approval must be by the ACO or the office of the TAD having oversight responsibility for the relevant type certificate.</p>	
<p>Boeing</p> <p>Paragraph e(3), page 6 of commenter’s version Renumbered as paragraph d(3), page 9</p>	<p><u>Paragraph e(3), Instructions for Continued Airworthiness</u> Paragraph e(3) states that changes to either freeplay limits or inspection intervals require FAA engineering approval (by either the ACO or TAD staff). It is requested that approvals of limited expansion of freeplay limits and/ or limited extension of inspection intervals should be extended to the Designated Engineering Representative (DER)/Authorized Representative (AR) community and documented via FAA Form 8110-3/FAA Form 8100-9. DERs/ARs can best assess if limited temporary expansion of freeplay tolerances or limited expansion of an inspection interval can be granted without eroding safety margins within stated constraints.</p>	<p>The FAA partially agrees with the commenter’s proposal. Reference to FAA approval is removed, and the current process established in AC 25-19 is emphasized.</p>
<p>Embraer</p> <p>Text on pages 1, 2 ,5, and 8 of commenter’s version Renumbered as pages 1, 2, 4, 8, and 10</p>	<p><u>Term used in policy memo.</u> The term “Other nonlinear features” is very wide. Change “Other Nonlinear Features” to “Other Structural Nonlinear Features”.</p>	<p>The FAA disagrees. The terminology should be broad enough to include, e.g., nonlinear damping and nonlinear aerodynamics, if applicable.</p>

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<p>page 1</p> <p>Embraer, comments continued</p>	<p><u>Summary (1st paragraph)</u> Redundant sentence. Exclude the sentence: “and limit cycle oscillation (LCO)”.</p>	<p>The FAA disagrees with the proposed change. An aeroelastic configuration can be nonlinear but stable, i.e., no LCO. The FAA recognizes that for certain failure cases, while divergent flutter is prevented, the means of flutter prevention is nonlinear and results in a limit cycle oscillation. Thus, this memorandum provides an acceptable means of compliance for those failure cases that prevent divergent flutter but result in LCO.</p>
<p>page 2 of commenter’s version and final policy</p>	<p><u>Current Regulatory and Advisory Material (2nd paragraph)</u> The text is not clear. Change “The safety concern is that excessive vibration or LCO could lead to structural damage, divergent flutter, or reduced controllability of the airplane” to <u>“The safety concern is that excessive amplitudes of aeroelastic response could lead to airframe-limiting structural fatigue, structural damage, and structural catastrophic failures. In addition, it could compromise the ability of pilots to perform critical mission-related tasks or reduce the controllability of the airplane”.</u></p>	<p>The FAA agrees to the proposed change.</p>
<p>Page 2 Renumbered as page 4 of commenter’s version and final policy</p>	<p><u>Relevant Past Practice (4th paragraph)</u> The term “non-linear element” is very wide. Change “non-linear element” to <u>“structural nonlinearities”.</u></p>	<p>The FAA disagrees.</p>

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<p>Embraer</p> <p>Page 3 of commenter's version Renumbered as page 5</p>	<p><u>Interim Guidelines (1st paragraph)</u> This is a redundant paragraph. This paragraph is re-named "Policy"</p>	<p>The FAA disagrees. This paragraph is renamed Policy.</p>
<p>Paragraph a, page 3 of commenter's version Renumbered as Paragraph b, page 6</p>	<p><u>Paragraph a, "Freeplay in Control Surface Design"</u> Section 25.629 does not make any mention about LCO. Exclude: "and will not result in an aeroelastic LCO (freeplay-induced vibration)".</p>	<p>The FAA agrees. The memo no longer paraphrases the requirements, but includes the complete text of § 25.629 at Amendment 25-77. The new paragraph a is titled "Acceptability of Freeplay-Induced LCO within the Design Envelope."</p>
<p>Paragraph b, page 4 of commenter's version Renumbered as Paragraph a, page 5</p>	<p><u>Paragraph b, "Acceptability of Freeplay-Induced LCO within the Design Envelope."</u> An LCO is an intrinsically nonlinear phenomenon. It is not clear the criteria to confirm the adequacy of large freeplay limits since it's not established maximum amplitude of oscillation.</p>	<p>No recommendation was made. The acceptable amplitude would be configuration dependent. The LCO would be addressed by criteria in the new paragraph b, "Freeplay in Control Surface Design."</p>
<p>Paragraph c, page 5 of commenter's version Renumbered as Paragraph c, page 8</p> <p>7/3/07</p>	<p><u>Paragraph c, "Aeroelastic Stability Analyses"</u> The text is not clear. Change "Applicants should evaluate the effect on flutter margins of freeplay due to in-service wear in components, such as control surface actuators and hinge bearings when showing compliance with the aeroelastic stability requirements of § 25.629" to "Applicants should evaluate the effect on flutter margins of freeplay due to in-service wear in components, such as control surface actuators and hinge bearings, <u>that leads to overall control surfaces</u></p>	<p>The FAA disagrees. AC 25.629-1A requires that control surface parametric variations include the effect of freeplay on flutter margin and should be done irrespective of the magnitude of the certified allowable freeplay.</p> <p>7</p>

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<p>Embraer, Continued</p> <p>Paragraph (c), page 5 of commenter's version, renumbered as page 8</p> <p>Paragraph c, page 5 of commenter's version, Renumbered as Paragraph c, page 8</p> <p>Paragraph d(1), page 5 of commenter's version, Included in renumbered Paragraph b, page 6</p>	<p><u>rotational freeplay values greater than MIL-A-8870C</u>, when showing compliance with the aeroelastic stability requirements of § 25.629”</p> <p><u>Interim Guidelines (c) (1st paragraph)</u> The term “non-linear element” is very wide. Change “non-linear element” to <u>“structural nonlinearities”</u>.</p> <p><u>Paragraph c, “Aeroelastic Stability Analyses”</u> The text is not clear. Change ”freeplay-induced vibration” to <u>“LCO”</u>.</p> <p><u>Paragraph (d)(1), “Failure Conditions”</u> Does “Stable condition” mean LCO stable? Change “Result in a stable condition” to <u>“result in stable LCO”</u>.</p>	<p>The FAA disagrees.</p> <p>The FAA disagrees. The focus should be on the example of control surface freeplay-induced vibration which, of course, is an LCO.</p> <p>The FAA agrees. This paragraph (now included in paragraph b) is rewritten to clarify.</p>

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<p>Gulfstream</p> <p>Paragraph e(2) and (3), page 6 of commenter's version Renumbered as Paragraph d(1) and (2), page 8</p> <p>Paragraph b, page 4, Renumbered as paragraph a, pg 5 and Paragraph c, page 5, of commenter's version, now appears on page 8</p> <p>Paragraph c, page 5 of commenter's version, now appears on page 8</p>	<p><u>Paragraph (e)(2) and (e)(3), "Instructions for Continued Airworthiness"</u> There is a well established procedure that considers the safety assessment analysis, proposals of periodic inspection intervals, etc. Include in paragraph (e)(2): <u>The certified static and/or dynamic balance limits of control surfaces that rely on mass balance for flutter prevention must be established in Airplane Maintenance Manual. Include in tem (e)(3): Airplane maintenance manual freeplay limits substantiated during certification along with measurement procedures and inspection intervals must be established.</u></p> <p>Paragraph b permits the use of analysis for determining the effects of freeplay, and Paragraph c describes the validation requirements for any analysis tool used</p> <p>Although paragraph c describes some means of validation, it is the opinion of Gulfstream Aerospace that paragraph c is vague as to the extent of validation required. Gulfstream recommends that additional guidance be provided.</p>	<p>The FAA partially agrees. Paragraph e (now renumbered as paragraph d) was rewritten in response to this and other comments, as described above.</p> <p>Much of the Gulfstream approach to validation of flutter methods are, or should be, covered in AC 25.629-1A. The FAA feels that no additional guidance on validation is needed in this memorandum.</p> <p>The second paragraph of paragraph c specifically relates to the situation where a nonlinear aeroelastic analysis is required. This paragraph discusses validation, over and above that required for a conventional flutter analysis, that would be necessary for the nonlinear analysis.</p>

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<p>Raytheon</p> <p>Paragraph e, page 6, of commenter's version, Renumbered as Paragraph d(2) and d(3), page 9</p> <p>Summary paragraph, page 1</p> <p>Relevant Past Practice paragraph, page 3 of commenter's version, now appears on page 5</p>	<p><u>Mass Balanced Control Surfaces</u> The control surfaces that are mass balanced appear to be exempt from these guidelines. However, because of some references made in the proposed text to "partially mass balanced surfaces," it would be advisable to include a clear statement regarding applicability. For example, the text could be modified to state that the guidelines are intended for control surfaces with a mass unbalance of more than 5 percent (defined as the ratio of the streamwise distance from the hinge line to center of gravity (CG) and the mean geometric chord of the control surface aft of the hinge line).</p> <p><u>High-Lift Devices</u> Please clarify if the guidelines are intended to apply to high-lift devices (e.g., flaps) too.</p> <p><u>Inadequacy of Linear Analysis</u> It is recommended to rectify the statement on page 3 "Accounting for freeplay by linear analysis, while adequate to prove freedom from divergent flutter, has been inadequate to prove freedom from LCO." Piecewise linear analysis has been successfully used in the prediction of LCO (e.g. "Analysis of Piecewise Linear Aeroelastic Systems Using Numerical Continuation" by I. Roberts et al, Proc IMechE, Part G: Journal of Aerospace Engineering, Vol. 216, 1/2002, pp.1-11).</p>	<p>The FAA disagrees. Stating that the guidelines apply to control surfaces that rely on retention of stiffness for flutter prevention is sufficient and more general. This will include any control surface no matter what its static or dynamic imbalance. It also covers both intentional mass balance and control surfaces that have acceptable flutter margin without deliberately adding mass balance. If an applicant can show that the free control surface is flutter free, it doesn't matter how much unbalance there is.</p> <p>The following verbiage was added: "This guidance does not apply to devices used strictly for high-lift, e.g., leading and trailing edge flaps. However, if a high-lift device is also used for flight control, e.g., a flaperon, this guidance would be applicable."</p> <p>The FAA agrees and has adopted the substance of the Raytheon recommendation.</p>

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Raytheon, Continued	A correct statement would be “Accounting for freeplay by linear analysis utilizing a single slope for the whole domain is inadequate to evaluate LCO”.	
Paragraph a(2) and (3), page 4, Renumbered as paragraph b, page 6	<u>Added design feature to prevent freeplay-induced vibration</u> The difference between paragraph a(2) and a(3) is unclear. The condition in paragraph a(3) appears to address additional features for a control surface that already satisfies the condition paragraph a(2).	The FAA agrees that this paragraph was somewhat unclear and has rewritten it. The objective of the policy set forth in this memorandum is to achieve zero freeplay-induced vibration during normal operation of the airplane in addition to having a maintenance program in place to manage freeplay.
Paragraph a(3)(i) and (ii), page 4 Renumbered as paragraph b, page 6	<u>No LCO during normal conditions</u> The guidelines differentiate between normal and failure conditions. The requirement for normal conditions is that there will be no LCO (page 3). For failure conditions, a limited amplitude of the LCO is acceptable (page 5).	The policy memo is rewritten to clarify when LCO is acceptable. See new paragraph b, Acceptability of Freeplay-Induced LCO.
Paragraph a(3), page 4, of commenter’s version Renumbered as paragraph b, page 6	<u>Flight beyond V_C/M_C</u> It is generally accepted in the industry that for flight speeds above V_C/M_C some buffeting/LCO will develop, even in the absence of a structural failure. It is therefore suggested to include text in the guidelines that the limited amplitude LCO described in paragraph d (page 5) is also applicable to the no-failure (but abnormal) condition of flight at speeds above V_C/M_C :	The FAA agrees and the policy is rewritten to clarify as noted above.

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<p>Raytheon, Continued</p> <p>Paragraph c, page 5, Renumbered as paragraph c, page 8</p> <p>Paragraph d, page 5 of commenter's version Included in renumbered paragraph b, page 6</p> <p>Paragraph e, page 6, Renumbered as paragraph d, page 8</p>	<p>Paragraph c "Aeroelastic Stability Analyses" it is suggested to change the text to "demonstrate that LCO will not develop up to Vc/Mc".</p> <p>Paragraph d, "Failure Conditions." It is suggested to change the title of paragraph d to "Failure and Abnormal Conditions". An additional statement is needed that the LCO amplitude requirements of paragraph d apply also to "normal structural conditions", as defined in § 25.629, at abnormal speeds above Vc/Mc.</p> <p>Paragraph e, "Instructions for Continued Airworthiness," Clarify the terms "One-Star Certification Maintenance Requirement" and "Airworthiness Limitation Item". It would be good to include a reference to a regulatory document (e.g., 14 CFR 21.XXX).</p>	<p>The policy is rewritten to clarify as noted above.</p> <p>The policy is rewritten to clarify as noted above.</p> <p>The FAA disagrees. Reference is provided to AC 25.19, which defines One and Two Star CMRs. Reference is also provided to § 25.1529 and Appendix H.</p>