Appendix

to ED Decision 2018/014/R

RELATED NPA: 2017-16 — RMT.0671 — 13.12.2018

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1. Summary of the outcome of the consultation

Comments were received during the consultation of NPA 2017-16 on the following aspects:

— requests to improve the clarity of the engine conditions under which the bird ingestion test should be conducted;

— a request to limit the applicability of the new Medium Flocking Bird (MFB) core ingestion test to turbofan engines only;

— the need to improve consistency regarding the power lever movement between the climb condition test and the approach condition test;

— suggestions to improve the run-on schedule after the ingestion of the bird;

— requests for clarification on the intent of the target location for the bird test.

These comments were taken into account in the final composition of the amended CSs and AMC for bird ingestion testing.

2. Individual comments and responses

In responding to comments, a standard terminology has been applied to attest EASA's position. This terminology is as follows:

(a) **Accepted** — EASA agrees with the comment and any proposed amendment is wholly transferred to the revised text.

(b) **Partially accepted** — EASA either agrees partially with the comment, or agrees with it but the proposed amendment is only partially transferred to the revised text.

(c) **Noted** — EASA acknowledges the comment but no change to the existing text is considered necessary.

(d) **Not accepted** — The comment or proposed amendment is not shared by EASA.

(General Comments)	-

comment	*16* comment by: *Transport Canada Civil Aviation Standards Branch* In general, TCCA supports the proposed rule change which introduces the core flocking bird ingestion requirements to meet the safety objective for engine certification standards.
response	Noted. The support of TCCA is welcomed.

comment	*21* comment by: *EUROCONTROL* The EUROCONTROL Agency welcomes the publication of EASA Notice of Proposed Amendment 2017-16 on 'Engine bird ingestion'. It also thanks EASA for the opportunity that has been given to submit comments. In addition, despite the fact that it has no comments to make, the EUROCONTROL Agency would like to confirm that it will read with interest the comments on this NPA received from stakeholders and the responses given to them by EASA in its future comment-response document (CRD). Like for NPA 2017-16, EUROCONTROL staff will be given access to CRD 2017-16, for information.
response	Noted. The support of EUROCONTROL is welcomed.

comment	*22* comment by: *UK CAA* Please be advised that there are no comments from the UK CAA on NPA 2017-16, Engine Bird Ingestion.

response Noted.

The support of the UK CAA is welcomed.

comment *23* comment by: *DGAC France*

Please note that DGAC France has no specific comment on this NPA.

response Noted.

comment *27* comment by: *Luftfahrt-Bundesamt*

LBA has no comments on NPA 2017-16.

response Noted.

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comment *13* comment by: *FAA*

Section, table, figure	Page	Comment summary	Suggested resolution	EASA response
CS-E 800 (e)(7)(iv)	13	Incorrect reference in sub-paragraph (e)(7)(iv) to sub-paragraph (e)(7)(iv)	“Followed by 2 minutes with power or thrust reduced from that set in sub-paragraph (e)(7)(iii)…”	Accepted. The reference in paragraph (e)(7) has been amended.
Section 4.1.3	26	Minor grammar revision to remove extra “that” in the second paragraph, second sentence.	“Likewise the rate of bird ingestions per movement does not indicate that there is…”	Accepted. The typographical error has been corrected. The additional ‘that’ has been deleted.

Section 3.2, paragraph d(i)	16	1. The text refers to the installation of the engine which is not covered by CS-E. Recommend revision to emphasize coordinating with likely installers or using past experience and identifying assumptions in the engine installation manual. 2. Clarify if altitude is above ground level or above sea level. Discussion in section 4.3.1 on page 28 uses above ground level.	For each engine model ~~and installation~~, the engine manufacturer should: - Collaborate with the aeroplane manufacturer**, if known, or based on past experience,** to determine the engine thrust at a 3000 ft altitude **above ground level** that is required to climb through that altitude, in International Standard Atmosphere (ISA) standard day conditions at 250 knots indicated airspeed (KIAS). **Document assumed thrust used for this condition in the engine installation instructions.** - Establish the associated minimum mechanical fan rotor speed for this condition using engine performance simulations. - The fan speed chosen should be associated with the lowest rated thrust engine model offered for ~~that~~ aircraft installation. If multiple climb settings are available for ~~a particular~~ **an intended** aircraft, then the lowest climb setting should be used to determine the core ingestion rotor speed targets.	Partially accepted. An additional clarification has been added to allow an applicant to make assumptions about the engine conditions that were selected. Partially accepted. The text has been amended to include 'above ground level'. Partially accepted. The text has been amended to include 'intended aircraft'.

Section 4.3.1	29	The following statement only applies to twin-engine aircraft. "These provisions establish that at least 50 % of the highest-rated thrust for the tested model remains available from the engine after the ingestion to ensure a thrust equivalent to a single engine inoperative take-off condition in the event of multi-engine core ingestion, followed by an engine run-on profile to ensure engine power can be safely managed during an air turn back and landing." A 50 % loss of highest-rated thrust from each engine on an aircraft with three or more engines, when combined, is more severe than losing a single engine completely. It is not clear why the same thrust loss criterion applies to all aircraft.	Provide justification to why the same thrust-loss criterion applies to aircraft with three or more engines.	Not accepted. The MFB core ingestion permissible thrust loss is consistent with the LFB criteria, and accounts for the remote likelihood of multiple bird ingestions on an aircraft with three or more engines.
Section 4.3.1	29	Discussion in paragraphs on "Ingestion of medium flocking birds during approach" there is no discussion on the potential for a flightcrew to initiate a go-around following the bird ingestion. This outcome should be considered and discussed why it is not included in the test demonstration requirement.	Identify that it is not necessary to include the capability for go-around following medium flocking bird ingestion during approach and provide justification for not including this capability.	Not accepted. The MFB core ingestion criteria is consistent with the LFB criteria, which do not require the inclusion of a go-around.

Section 4.3.1	28	It is not clear why 250 KIAS is the critical condition during take-off and climb. It appears to be based on the combination of the simulation data discussed showing increased bird mass ingestion as bird speed is increased and the information stating that expected flight speeds up to 3000 ft. above ground level are 150 to 250 KIAS. The section should clearly state why 250 KIAS is the critical condition so that future changes in operations can be assessed to ensure the requirement remains valid. Note that section 4.3.1 on page 29 in the discussion on "Ingestion of medium flocking birds during approach" describes 200 KIAS is typical during approach at 3000 ft. above ground level.	Add a statement that clearly shows why using 250 KIAS as the aircraft speed for determining climb rotor speeds is the critical condition and what assumptions it is based on.	Not accepted. The justification of the 250 KIAS is contained within the referenced report and is based upon the typical range of airspeeds. The most challenging airspeed was selected.

response Please refer to the responses to the individual comments in the table above.

3. Proposed amendments and rationale; 3.1 Draft CS-E800 Bird Strike and Ingestion p. 7-14

comment *1* comment by: *Francis Fagegaltier Services*

This NPA is proposing to change significantly the interpretation of the whole CS-E 800 without explaining at all the rationale for this change : indeed, by deleting the capital "E" in "Engine", or the capital letters in "Hazardous Engine Effect" (I have not checked all similar changes in the whole new text, but there are others, obviously), this proposal is no longer consistent with CS-E 15 (a).This important change should be explained.

	If the proposed "engine" in this NPA is no longer the defined word "Engine" as it was in current CS-E, what is its new meaning ? If the proposed "hazardous engine effects" are no longer the defined "Hazardous Engine Effects" of curent CS-E 800, what are they ?
response	Accepted. These changes were introduced during the editorial revision. The text has been reverted back to the original format using initial capitals for these terms.

comment	*5* comment by: *CAA-NL*
	1. CS-E 800 (e)(1): The sentence "*lowest expected power or thrust required during a climb through 3 000 ft above ground level in revenue service*" implies that the engine manufacturer knows what that thrust setting should be (as explained by EASA in the AMC material). However, when new engines are developed and certified, this might not always be the case. Same is applicable for CS-E 800 (e)(5) with the sentence "*would produce the power or thrust required during approach at 3 000 ft above ground level*".
response	Accepted. AMC 800 (d)(i) has been reworded to clarify the criteria that should be used for the engine manufacturer to determine the thrust setting for the test.

comment	*6* comment by: *CAA-NL*
	1. CS-E 800 (e)(4): Why not referring to the test schedule in paragraph CS-E 800 (c)(1)(v)?
response	Not accepted. It is advantageous to maintain separate test schedules for Medium Flocking Birds and Large Flocking Birds as it maintains the clarity of what is required for each test.

comment	*10* comment by: *FAA*
	The current requirement applies to all engines except rotorcraft engines. The FAA recommends changing this to "For Turbofan engines, an ingestion test shall be performed...." Reason: Turboprop engines are tested at the CS-E level without a propeller and the bird is shot directly at the core; there is no centrifuging effect as seen on turbofan engines. Alternately, wording could be included to cover both turbofan and open-rotor engines (when covered by future rulemaking).
response	Accepted. The Medium Flocking Bird core ingestion test is limited to turbofan engines. The text of CS E 800(e) has been changed to 'For turbofan engines, an ingestion test shall be performed as follows'.

comment	*12* comment by: *FAA*

Paragraph (d)(vi) of the proposed AMC, last sub-bullet, is not consistent with the ARAC working group recommendations, and may more appropriately be proposed as an equivalent safety finding. To justify that the CS-E 800 (d) test was more severe than the CS-E 800 (e) test, the applicant would have to show that the relative kinetic energy of the bird mass entering the core (vs. the core airfoils) is higher than that of the CS-800 (e) bird mass entering the core. Note that the ARAC working group was unable to quantitatively determine how much bird material would be ingested into the core at any given test condition; the ARAC working group only showed that applicants are capable of determining the best bird target location to maximize core bird material ingestion.

response

Accepted.
In the unlikely scenario in which significant bird mass enters the core during the CS E 800(d) test, the applicant may consider proposing an equivalent safety finding. This approach is consistent with the ARAC report and is in alignment with international certification partners.

comment 14 comment by: *Transport Canada Civil Aviation Standards Branch*

This section of new rule proposes "…. Prior to the ingestion, the engine must be stabilised at the mechanical rotor speed of the first exposed stage or stages that, on a standard day, would produce the power or thrust required during approach at 3 000 ft above ground level ."

This rotor speed setting requirement is not consistent with EHWG recommendation in which the "approach idle speed" is clearly required. Ref to the section 6.1 on page 26, quote " ...that the engine can ingest the largest medium flocking bird at the approach condition (defined as 200 KIAS and approach idle rotor speed) and be capable of safely continuing a stable approach and safe landing."

Use of the phrase "power or thrust required during approach" might lead to or could be interpreted to apply the engine power setting higher than approach idle and result in higher rotor speed which essentially reduce the potential bird core ingestion and lower the safety standards intended to achieve in this rule making.

TCCA recommends to revise the proposed rule in CS-E 800.(e).(5) to "….Prior to the ingestion, the engine must be stabilised at the mechanical rotor speed of the first exposed stage or stages that is consistent with an approach idle setting, on a standard day, ~~would produce the power or thrust required during approach~~ at 3 000 ft above ground level."

response

Partially accepted.

CS E 800 (e)(4) has been reworded to include the following text:

'Prior to the ingestion, the Engine must be stabilised at the mechanical rotor speed of the first exposed stage or stages that is consistent with a minimum approach idle setting, on a standard day, at 3 000 ft above ground level.'

comment 15 comment by: *Transport Canada Civil Aviation Standards Branch*

	It is believed that these proposed run-on requirements (6-minute run-on) are intended to apply to the core bird ingestion in approach phase should the engine configuration be shown by analysis or test to eject 100% of the bird material from the core. TCCA recommends to move this section to under the section CS-E 800.(e).(5) and make it a sub-section of CS-E 800.(e).(5). In addition, TCCA recommends to apply the same requirements of power lever movement prescribed for the final 6-minute in CS-E 800.(e).(4).(vii)
response	Partially accepted. The text of CS E 800 (e)(2) has been incorporated into CS E 800 (e)(1) and (5). Accepted. The following text has been added to CS E 800 (e)(6): 'Power lever movement between each condition shall be 10 seconds or less in duration, except power lever movements allowed within subparagraph (e)(6)(iii), which are not limited, and those for setting power under subparagraph (e)(6)(iv) shall be 30 seconds or less in duration.'

comment	*17* comment by: *Transport Canada Civil Aviation Standards Branch* The intent of this new rule is to allow the core ingestion test to be combined with the medium flocking bird ingestion test under the condition "if the climb fan rotor speed calculated in sub-paragraph (e)(1) is within 1 % of the first stage rotor speed required by sub-paragraph (d)(1). " However AMC E 800.(1).(d).(ii) states "The objective is to show that the core ingestion is as rigorous at the current MFB fan speed condition as it would be at the aeroplane recommended climb fan speed condition.". Since current MFB fan speed is required to be at 100% rated take off power or thrust, the objective statement in the AMC appears to be relaxing the rule requirement on the first stage rotor speed and counter-productive to the intent of the CS-E 800.(e).(9). TCCA recommends to remove the objective statement "The objective is to show that the core ingestion is as rigorous at the current MFB fan speed condition as it would be at the aeroplane recommended climb fan speed condition" in AMC E 800.(1).(d).(ii).
response	Not accepted. The objective is as stated in AMC E 800(1)(d)(ii).

comment	*20* comment by: *Transport Canada Civil Aviation Standards Branch* The proposed rule states "The bird must be targeted on the first exposed rotating ….. that would result in the <u>most</u> bird material being ingested into the engine core."

	The intent of this ingestion target seems deviated from the one in the EHWG recommendation 6.6.1, which states "bird should be targeted at the engine to maximize the amount of bird material that enters the core…" Given the intent of target location is to demonstrate the max amount of bird material entering the core, TCCA recommends to adopt the word "maximize" in EHWG's report in lieu of word "most" which might not be achievable in particular engine design with material ejection technology.
response	Accepted. CS E 800 (e)(1) and (4) have been amended as follows: 'The bird must be targeted on the first exposed rotating stage or stages at the blade airfoil height measured at the leading edge that would maximise the bird material being ingested into the Engine core.'

comment	_24_ comment by: _The Boeing Company_ Page: 11 Paragraph: _(e)_ **THE PROPOSED TEXT STATES:** "(e) _Core engine flocking bird ingestion test._ Except for rotorcraft engines, an ingestion test shall be performed as follows:" **REQUESTED CHANGE:** "(e) _Core engine flocking bird ingestion test._ ~~Except for rotorcraft~~ For turbofan engines, an ingestion test shall be performed as follows:" **JUSTIFICATION:** The original wording would require the testing for turboprop and open rotor designs. Turboprop engines should be covered by the current rule and open rotor engines will be covered by rules currently being written.
response	Accepted. The Medium Flocking Bird core ingestion test is limited to turbofan engines. The text of CS E 800(e) has been changed to read: 'For turbofan engines, an ingestion test shall be performed as follows'.

comment	_25_ comment by: _The Boeing Company_ Page: 12 Paragraph: _(e)(5)_ **THE PROPOSED TEXT STATES:**

"Prior to the ingestion, the engine must be stabilised at the mechanical rotor speed of the first exposed stage or stages that, on a standard day, would produce the power or thrust required during approach at 3000 ft. above ground level."

REQUESTED CHANGE:

"Prior to the ingestion, the engine must be stabilised at the mechanical rotor speed of the first exposed stage or stages that, on a standard day, would produce the approach idle power or thrust required during approach at 3000 ft. above ground level."

JUSTIFICATION: The EHWG report had recommended approach power for the test. This test is used only if there is no core ingestion during climb power. Therefore to increase the chance of material going in the core, approach idle was recommended.

response Partially accepted.
Please refer to the response to comment #14.

comment *26* comment by: *Textron Aviation*

There appears to be a typographical error in the proposed rule wording, CS-E 800(e)(7)(iv) refers to itself:

Current:

(e) Core engine flocking bird ingestion test. Except for rotorcraft engines, an ingestion test shall be performed as follows:…
(7) The following test schedule must be used: …
(iv) Followed by 2 minutes with power or thrust reduced from that set in sub-paragraph (e)(7)(iv), by between 5 and 10 % of maximum rated take-off power or thrust.

Reason for Change:

Reference should be to (e)(7)(iii) to match the run on profile defined in 14 CFR §33.76(d)(5)(iii) through (vii) as recommended by the ARAC working group:

Proposed Change:

(e) Core engine flocking bird ingestion test. Except for rotorcraft engines, an ingestion test shall be performed as follows:…
(7) The following test schedule must be used:…
(iv) Followed by 2 minutes with power or thrust reduced from that set in sub-paragraph (e)(7)(iii), by between 5 and 10 % of maximum rated take-off power or thrust.

response	Accepted. The reference has been changed as suggested.

3.2. Draft AMC E800 Bird Strike and Ingestion p. 14-20

comment	*7* comment by: *CAA-NL* 1. AMC E 800 (1)(d)(iv): The second bullet should read "*A power or thrust loss of greater than 3 seconds duration* ***below the required value of each segment, or when setting power between segments,*** *is considered to be a sustained power loss.*".
response	Accepted. The text of AMC E 800 (1)(d)(iv) has been amended as follows: 'A power or thrust loss of greater than 3 seconds duration below the required value of each segment, or when setting power between segments, is considered to be a sustained power loss.'

comment	*8* comment by: *CAA-NL* 1. AMC E 800 (1)(d)(vi): In the first bullet, the term "take-off and climb conditions" are mentioned. It would be more clear to refer to the conditions of CS-E 800(e)(1) and CS-E 800 (e)(5).
response	Partially accepted. The reference to CS E 800 (e)(1) and (d) has been added.

comment	*18* comment by: *Transport Canada Civil Aviation Standards Branch* The intent of this new rule is to allow the core ingestion test to be combined with the medium flocking bird ingestion test under the condition "if the climb fan rotor speed calculated in sub-paragraph (e)(1) is within 1 % of the first stage rotor speed required by sub-paragraph (d)(1). " However AMC E 800.(1).(d).(ii) states "The objective is to show that the core ingestion is as rigorous at the current MFB fan speed condition as it would be at the aeroplane recommended climb fan speed condition.". Since current MFB fan speed is required to be at 100% rated take off power or thrust, the objective statement in the AMC appears to be relaxing the rule requirement on the first stage rotor speed and counter-productive to the intent of the CS-E 800.(e).(9). TCCA recommends to remove the objective statement "The objective is to show that the core ingestion is as rigorous at the current MFB fan speed condition as it would be at the aeroplane recommended climb fan speed condition" in AMC E 800.(1).(d).(ii).
response	Not accepted.

The objective is as stated in AMC E 800(1)(d)(ii).

comment | *19* comment by: *Transport Canada Civil Aviation Standards Branch*

In the 2nd paragraph, the term "the fan critical bird speed" seems confusing when comparing to o 250 knots bird speed in the same sentence.

TCCA recommends to remove the word "fan" in the phrase by reading as "the critical bird speed".

The proposed rule states "The bird must be targeted on the first exposed rotating ….. that would result in the most bird material being ingested into the engine core."

The intent of this ingestion target seems deviated from the one in the EHWG recommendation 6.6.1, which states "bird should be targeted at the engine to maximize the amount of bird material that enters the core…"

Given the intent of target location is to demonstrate the max amount of bird material entering the core, TCCA recommends to adopt the word "maximize" in EHWG's report in lieu of word "most" which might not be achievable in particular engine design with material ejection technology.

response | Accepted.
AMC E 800 (d)(ii) has been amended to read:
'The most significant difference between the MFB test and the core ingestion demonstration is expected to be the bird speed determined in CS-E 800(f) versus the 250 KIAS core Engine test bird speed.'

Accepted.
CS E 800 (e)(1) and (4) have been amended to state:
'The bird must be targeted on the first exposed rotating stage or stages at the blade airfoil height measured at the leading edge that would maximise the bird material being ingested into the engine core.'

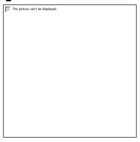
comment | *29* comment by: *GE Aviation*

Attachment #1

Comment #1 – ref. CS-E 800 (e). *Core engine flocking bird ingestion test.*
In the Turbofan Bird Ingestion Regulation Engine Harmonization Working Group (EHWG) Report (dated 2/19/2015), the EHWG recommendation is that the current regulatory requirements of §33.76 "be modified by including an additional core ingestion demonstration, by test, analysis, or both, of the largest Medium Flocking Bird (as defined in 14 CFR § 33.76 Table 2) at a climb condition which reflects the highest typically allowed aircraft speed (defined as 250 KIAS) and the lowest climb fan rotor speed expected to occur during the climb phase at 3,000' AGL."
GE has reviewed the entire contents of the EHWG report. The EHWG reports notes that the group's "study used updated bird ingestion data covering the period of Jan. 2000 thru Jan. 2009, which includes over 11,000 bird ingestion records covering over 250 million flights."
Further on in the EHWG report the following data table is provided:

Table 2.2.2.1 Core Ingestion Power Loss for Engine Size Class and Flight Phase

[see attachment]



This data table shows that the EHWG's database contained no reported loss of power events associated with core bird ingestion, involving Class A size turbofan engines within the group's compiled data set. (Class A being engines of inlet area greater than 3.9 m^2).
Within the database analysis section of the EHWG report the following statement is made (emphasis added): "The data shows that all engine size classes, with the exception of Class A which had no core ingestions that resulted in power loss, had the highest percentage during the climb phase."
Conversely, the EHWG database shows that a number of bypass (fan) ingestion events with associated power loss have been reported (reference Table 2.2.2.2: Bypass Ingestion Power Loss for Engine Size Class and Flight Phase, of the EHWG 2/19/2015 report).
A review of the most recent and relevant medium flocking bird certification (class A-size) engine tests shows that when these recent legacy large turbofan engines were evaluated and tested to the current requirements of CS-E 800 (d)(1)(i) and CS-E 800 (d)(iv)(A) (i.e. "…When two or more birds are specified, the largest must be aimed at the engine core primary flow path…") the compliance engine testing has resulted in evidence of bird matter being ingested into each of the engine's core flow path. In these legacy engine tests, ingestion of bird matter into the core flow path resulted in acceptable post-ingestion engine response and serviceable post-test, core hardware conditions, thus demonstrating that the current rule provides an appropriate mechanical and operational challenge to the largest class of turbofan engines.
In summary, the EHWG report provides no evidence that core ingestion of medium-size (~2.5 lbs) bird represents a loss-of-power threat for an engine in the Class A size class within any flight phase and recent and relevant large turbofan legacy CS-E 800/§33.76(c) compliance testing results provide clear evidence of core ingestion. Therefore, compliance to the medium bird ingestion requirements found in the current CS-E 800 will present an appropriate and operationally relevant medium bird ingestion challenge for the largest size class of engines.
Therefore, it is recommended that the wording of the proposed rule be modified such that the "core ingestion" requirements exclude those engines with inlet area greater than or equal to 3.9 m^2 when the applicant can show that the proposed type design engine possesses design features and functions consistent with the applicant's successful medium bird ingestion legacy field service experience and legacy core ingestion compliance demonstrations.

response

Not accepted.

Between 2000 and 2009, there were between 12 and 20 million aeroplane cycles per year with Class D size engines. During the same time, there were less than 2 million aeroplane cycles per year with Class A size engines. Along with the rarity of engine power loss events, that makes it difficult to say that the lack of Class A-sized engine power loss events during that period is significant.

ARAC did not make an exception for Class A size engines or other sizes with relatively few core power loss events. The ARAC consensus described in Section 5 of the ARAC report was that the current core ingestion demonstration criteria did not adequately represent the most critical flight phase with respect to core ingestion due to the combination of high fan rotor speed and low aircraft speed. The ARAC working group discusses these factors in Section 3.2 of the report.

With respect to signs of bird remains that are found on the spinner or in the core inlet area after the current MFB test: ARAC report paragraph 4.3, Differentiating Between Core Induced Power Loss vs. Material in the Core says, in part: 'It is believed that the presence of bird remains within the engine core is not a reliable indicator of significant core ingestion because bird strikes on aircraft structure other than the core intake area, such as the inlet lip, spinner cap, and radome, regularly result in some amount of avian material entering the core. Single bird impacts which have occurred in the outer spans of the fan blades or against the front of the core intake fairing also are known to result in material entering the core. Accurate core ingestion data are of particular concern when attributing an engine power loss event to a strike location on the engine and airframe, with a distinction made between the ingestion of significant amount of bird debris, such as the main body of the bird, directly into the core and ingestions of small amounts of material secondary to a primary strike at another location.'

During a certification test, therefore, it is not possible to accurately measure the amount of bird material that entered the core, as opposed to entering the bypass.

comment *30* comment by: *GE Aviation*

Comment #2 – ref. CS-E 800 (e). *Core engine flocking bird ingestion test.*
The NPA as stated reads "Core engine flocking bird ingestion test. Except for rotorcraft engines, an ingestion test shall be performed as follows…" The statement only excepts rotorcraft engines and thus the propose rule requires turboprop as well as new architecture engines to comply with the core ingestion requirement. In addition, the EHWG report referenced in this NPA clearly only evaluated turbofan engines, and specifically those with modern wide-chord fan blades. The rule would also be applied to new architecture engines such as the open rotor which is the subject of another current rulemaking effort. CS-E-800 (e) should be changed to only apply to turbofans to read "Core engine flocking bird ingestion test. For Turbofan engines, an ingestion test shall be performed as follows…"

response Accepted.

The Medium Flocking Bird core ingestion test is limited to turbofan engines. The text of CS E 800(e) has been changed to read: 'For turbofan engines, an ingestion test shall be performed as follows'.

comment *31* comment by: *GE Aviation*

Comment #3 – ref. CS-E 800 (e)(5). If it is shown by test or analysis…
In the EHWG report recommendation, the team had written "For engine configurations which are shown by analysis or test to eject 100% of the bird from the core under the proposed climb conditions, it must be demonstrated by test, analysis, or both that the engine can ingest the largest medium flocking bird at the approach condition (defined as 200 KIAS and approach idle rotor speed) …"

In this NPA, it is written "If it is shown by test or analysis that no bird material will be ingested into the engine core under the conditions of sub-paragraph (e)(1), then the core engine ingestion test shall be performed with one bird using the heaviest bird specified in the second column of Table A and ingested at a bird speed of 200 knots. Prior to the ingestion, the engine must be stabilized at the mechanical rotor speed of the first exposed stage or stages that, on a standard day, would produce the power or thrust required during approach at 3 000 ft above ground level."
The EHWG report specified approach idle rotor speed, whereas the NPA specifies approach. This wording could result in confusion of the requirement since the word "approach" does not set a power level. The word idle should be added following approach to read "…Prior to the ingestion, the engine must be stabilized at the mechanical rotor speed of the first exposed stage or stages that, on a standard day, would produce the power or thrust required during approach idle at 3 000 ft above ground level."

response Accepted. Please refer to the response to comment #14.

comment *32* comment by: *GE Aviation*

Comment #4 – ref. AMC E 800 (1)(d)(iii). Target selection and timing
This section of the AMC is very subjective making it difficult, during a certification test, to evaluate if the bird material entering the core was maximized. In the current CS-E 800 (d), a bird is required to be targeted at the core, however the AMC E 800 (1)(c) is silent on assessing if any material has entered the core of the engine during the certification test demonstration. GE's experience has been that when conducting testing to AMC E 800 (d), evidence of bird material entering the core has been found for all the latest engine tests. Since no AMC guidance existed in those tests, GE recommends that the following paragraph be removed from AMC E 800 (1)(d).
(iii) Target selection and timing.
— The bird should be targeted at the engine in order to maximize the amount of bird material that enters the core for the given test condition. This will ensure that the core ingestion test properly challenges the core during an engine demonstration.
— The optimum target location varies with engine design. The span-wise location will depend on the geometric features of the front of the engine.
— The core bird target location should be determined so that it maximizes the amount of core ingested bird material for the core ingestion test by:
• analysis based on component testing,
• dynamic simulation verified by test, or
• experience with similar designs.

(iii) Target selection and timing.

response Not accepted.
The guidance that is provided will ensure the consistency of the approach in the selection of the target location.

comment *33* comment by: *GE Aviation*

Comment #5 – ref. CS-E 800 (e). ***Core engine flocking bird ingestion test.***

	The term "core" has been used in the current and proposed rule. We recommend that the AMC include a better description of the term "core" when used to assess bird material. As an example, it should be considered that bird material entering the booster (low pressure compressor) on a two-spool turbofan is sufficient to satisfy the intent of the proposed rule.
response	Not accepted. The term 'core' is already used in CS-E without any issues. Therefore, there is no intention to define the term 'core'.

4. Impact assessment (IA) p. 21-34

comment *28* comment by: *Capt. Paul Eschenfelder*

Attachment #2

Comment on EASE Notice of Proposed Amendment 2017-16, Engine Bird Ingestion RMT.0671

4.3.1 Safety Impact - needs to be revisited. Empirically we cannot be "…on track to meet the desired safety goal…" if we have, in fact, suffered four high severity events (two catastrophic) within a twelve-month period. In January, 2009, an A320 crashed into the Hudson River after bird ingestions to both engines. Three months prior to that event a B737 was destroyed at Rome's Ciampino Airport after bird ingestions to both engines during approach. Three months prior to that accident, at Bourgas, Bulgaria, an A320 ingested birds into both engines during takeoff resulting in significant damage to both engines. In October, 2009 a B737 suffered a dual ingestion, damaging both engines, in Ireland.

While a huge amount has been written regarding the Hudson River crash, the catastrophic loss at Ciampino and the high risk at Bourgas seem to have been lost. It is true the ANSV has not released an official accident report on the Ciampino accident but, on February 12, 2009 the ANSV released a press report indicating that they were cooperating with accident officials from industry and government in the EU and the US. Independent accident investigations also followed.

In the Ciampino accident the pilot reported that a huge cloud of starlings engulfed the aircraft while on final approach. As he applied power to attempt a go-around both engines failed to respond. He reported they were both "…stuck around 40% N1". Out of thrust, altitude, ideas and options he dead-sticked the aircraft onto the runway. The impact of the landing causing it to suffer extensive damage and the B737 was written off as destroyed. Tear down of the engines indicated that organic material was present in quantity in the cores of both engines.

These events call into question both the way the EHWG assesses safety and the engine ingestion standards currently in place. We are still approaching the hazard in the 20th century manner, i.e., without safety management practices as detailed by

ICAO in Annex 19. We are not assessing risk, rather we are relying on engineering statistical modeling to compute safety. We, therefore, actually require failures before deciding if risk is high enough to require corrective action. On the other hand, SMS assesses the threat prior to failure. Under SMS principles a catastrophic event is not required to implement corrective action. While the EHWG go into detail regarding engine power losses during a 10-year period, they do not survey actual aircraft accidents caused by bird ingestion.

We suggest that the AIA's effort to collect appropriate bird strike data for the EHWG, although laudable, is hamstrung by the decision to completely sanitize the data to erase any clues as to the manufacturer of the engines involved. This effort may be of relief to the manufacturers but should be of concern to air travelers: we are not seeing an accurate representation of the risk. The issue is not about how many engines fail, but rather the risk to the system: the aircraft. Parsing individual engine failure data does not necessarily reflect the risk of dual engine failure in twin-engine aircraft, the cause of catastrophes.

Further, the catastrophic loss of a Falcon 20 freight aircraft in Ohio in 2005 was due to "…complete loss of engine power…" due to multiple ingestions of birds into both engines according to the NTSB final report. Both engine cores were found to contain bird remains. The birds were a small flocking bird: mourning doves. It appears that both the Ciampino accident and the Ohio accident were caused by large flocks of small birds. In both incidents the accident bird flock sizes seem to be well in excess of the number contemplated by the current bird ingestion rule. Given that the Hudson River crash was caused by birds of a size in excess of the rule and the two small flocking bird crashes resulted from encounters with small birds in flock sizes in excess of the rule, regulators must feel a sense of unease regarding the adequacy of standards.

While it is true that these high severity numbers are quite small, they do not compare well with other natural hazards such as wind shear or volcanic ash, where the loss rate is zero. It is further true that, beyond the airport fence, there is absolutely no mitigation for this hazard beyond the robustness of the aircraft's engines. The effort to require 'run on' after an ingestion, allowing the aircraft to complete an air turnback, is a huge step forward for safety.

Regarding, in **4.3.1**, "Ingestion of small flocking birds", the "…data shows that these encounters with large numbers of small flocking birds have not resulted in permanent engine power losses…" is not supported by fact. We recite, above, two case studies of aircraft catastrophes caused by small flocking birds ingested into engine cores, causing thrust loss. We wonder what the relevance of the phrase "permanent engine power losses" is to the ability to prevent catastrophe. If, when thrust is required from the engine in critical phases of flight (takeoff, final approach) and thrust is not available, what is the point? It appears to be an attempt to wordsmith around a clear engineering problem. Either thrust is available and the airplane flies, or thrust is not available and the airplane crashes, as above. The survival of the system, the airplane, is the critical factor, not the functioning of an engine.

Finally, the acceptance of a new concept, SMS per ICAO Annex 19, is always slow and change is difficult. The authors recall the initial resistance at the EHWG over a dozen

	years ago when it was proposed that two engines on a twin-engine aircraft could actually be damaged/destroyed in the same event. The idea of developing a run on time to allow for air turnback was greeted, initially, with incredulity. Now the idea is expanding to the engine size most threatened by this hazard. Comments by Dr. Valter Battistoni and Capt. Paul Eschenfelder Appendix A for author detail
response	Noted. After careful consideration, the rationale and arguments made cannot be fully substantiated based upon the available statistical data and the contents/recommendations of the EHWG report. Therefore, no changes have been made to the scope or the text of the CS and the supporting AMC.

3. Appendix A — Attachments

attachment to comment #29.pdf

Attachment #1 to comment #29

attachment to comment #29

Turbofans Only for 1/2000 – 1/2009
Core ingestions filtered by Engine Class and Flight Phase

All core engine ingestions — Power loss events / number of core ingestions

			Core Ingestions														
				Engine Class							Engine Class						
Flight Phase	No. of Aircraft Events in Data Set	Percent of Data Set	No. of Events	A	B	C	D	E	F	Unknown	A	B	C	D	E	F	Unknown
Ground	295	3%	5		1	1	3				0.00	0.00	0.00	0.00	0.00	0.00	0.00
Takeoff	1,686	15%	320	6	19	17	254	12	12		0.00	0.00	5.88	0.79	0.00	0.00	0.00
Climb	1,279	11%	219	5	13	7	167	17	10		0.00	7.69	28.57	4.79	17.65	30.00	0.00
Cruise	58	1%	8	1	1	2	3	1			0.00	100.00	0.00	0.00	0.00	0.00	0.00
Descent	70	1%	11	1		1	6	2	1		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Approach	1,760	16%	290	11	27	9	210	25	8		0.00	3.70	0.00	3.81	4.00	25.00	0.00
Landing	1,003	9%	143	6	7	2	114	14			0.00	0.00	0.00	1.75	7.14	0.00	0.00
Unknown	5,073	45%	658	43	66	36	443	55	15		0.00	0.00	2.78	0.00	1.82	6.67	0.00
	11,224	100.00%	1654	73	134	75	1200	126	46	0							

Appendix A Battistoni.pdf