European Union Aviation Safety Agency

EASA responses to comments received on Environmental Protection Technical Specifications for VTOL-capable aircraft powered by tilting rotors

RELATED: ENVIRONMENTAL PROTECTION TECHNICAL SPECIFICATIONS FOR VTOL-CAPABLE AIRCRAFT POWERED BY TILTING ROTORS

12.12.2023: BEGINNING OF COMMENTING PERIOD

13.02.2024: END OF COMMENTING PERIOD

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1. Individual comments (and responses)

In responding to the comments, the following terminology is applied to attest EASA's position:

(a) **Accepted** — EASA agrees with the comment and any proposed change is incorporated into the text.

(b) **Partially accepted** — EASA either partially agrees with the comment or agrees with it but the proposed change is partially incorporated into the text.

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

(d) **Not accepted** — EASA does not agree with the comment or proposed change.

(General Comments)	-

comment *1* comment by: *Ulf Tengzelius*

Attachment #1

TWO MAYOR CONCERNS:

1. The stated lower frequency, 50Hz, in frequency bands to be studied as of the EPTS(noise) for VTOLs is not enough low - fundamental BPF for vehicles already flying is found to be as low as ca 20 Hz
(see Joby data level flight figure 6 in:
https://ntrs.nasa.gov/api/citations/20220006729/downloads/Aeroacoustics2022_Pascioni_STRIVES5.pdf)
If it is decided not to include frequency information and focus on a integrated metric a better alternative than EPNL is in my opinion LAeq for all flight conditions, not only for hover as stated in SUBPART B - NOISE EVALUATION METRICS NVTOL-TILT.1100 - Applicable noise evaluation metrics.

This point 2 relates to all sections were EPNL is mentioned

My motivation to point 2. "Include frequency information and use L_{Aeq} values rather than EPNL as ruling metric", follow below

The PNL and EPNL metrics were established the 1960s linked to the start of aircraft noise regulation. At that time, with the lack of computer power and digital data communication, one were stuck to very condensed/compact metrics and datasets, which is not the case any longer.

Considering the knowledge and capabilities of today its my view that there are no longer any principal obstacle to apply a more general metric such as noise spectra representing the vehicle as a sound source. E.g. A-weighted 1 m sound intensity levels, narrowband or 1/3-octave band spectra (+ significant tonal components) and directivities.

From narrowband sound pressure data sets it would be possible to compute the value of almost any metric at a given distance and direction from the source for given flight

	conditions (hover, ascent at specified angle speed ... etc.). It could be Lp(t,f), A-weighted, Lpmax, Sound Exposure Level, Leq, EPNL or some other metric than EPNL involving attempts to include a kind of subjective perception of sound. It should be noted that the PNL/EPNL metrics are aimed and used solely for aircraft noise certification - i.e. in contrary to e.g. LpAmax or Leq, the EPNL is not used for any other kind of community noise. This situation complicates direct comparisons between aircraft and other sound sources where one is defined in EPNL and the other in e.g. LAmax. Moreover, the EPNL is neither, at least not anywhere in Europe as of my knowledge, used as a guideline or limit value even for air traffic noise on ground. My view is that the proposed EPNL metric risks, in a completely unnecessary way, to "blur" the evaluation process for VTOLs as sound sources, not only for common people, but also for professionals. Regarding the expressed need for frequency information it can be worth to emphasise that without having access to the frequency spectrum a direct transformation of PNL or EPNL to more widely used metrics like Sound Pressure Level ("linear" or A-weighted) or SEL (Sound Exposure Level), or vice versa, is not possible. Such an access to vehicle noise data including frequency information set as requirement on the industry would enable more general and accurate information to the public and the society as a whole and giving the possibility to generate better noise-mapping and -mitigation, potentially support health. Such a demand on stronger transparency from the industry with regard to noise specifications would most likely not introduce any additional costs compared with a more limited EPNL data set.
response	Noted. Thank you for your comment. Herewith some information to answer your questions and considerations: • EASA has conducted a psycho-acoustic study (and will share the results at the 2024 Quiet Drones symposium) highlighting that EPNL of single-events is still the metric that correlates best with perceived annoyance, from a dataset of conventional and novel configurations (drones, VCA). The dataset linking annoyance vs EPNL does not show any obvious disconnect for novel designs, hence suggesting that the EPNL metric is still adapted to these vehicles. • Considerations regarding local noise are not part of EASA's noise certification remit, which is intended to regulate single-event noise of the design. Setting local noise limits (often with considerations of repeated or cumulated noise events) would breach the subsidiarity principle and remains the prerogative of National Aviation Authorities (NAAs) or municipalities. • Regarding the need to assist in local noise planning and inform the public, the EASA NORAH project, currently being extended from rotorcraft to UAS and VCA, will eventually provide noise hemispheres available to the general public for those kinds of vehicles. • Finally, NVTOL-TILT.1410 (a)(2) recommends that the acoustic signals be "recorded and stored for subsequent analysis", leaving room for specifying different metrics (some of which utilizing spectra below 50 Hz) if it becomes a need in the future.

comment	*3* comment by: *UK CAA* **Page No:** 1 **Paragraph No:** Introductory Note, and throughout **Comment:** The EPTS document acknowledges that the proposed specifications are based on content from Chapter 13 of ICAO Annex16, Volume I. Reproducing and rearranging the accepted Annex 16, Volume I, Chapter 13 and Appendix 2 text makes the specification more difficult to follow, and to identify any differences that there might be. It would be preferable to make direct references to specific paragraphs of Chapter 13 and Appendix 2 when such paragraphs are unchanged. **Justification:** Enhanced clarity and better understanding leading to consistent implementation.
response	Not accepted. Thank you for your comment and suggestion. While there is clear merit in adopting a format widely recognised within the aircraft noise community, and while this was considered from the very beginning of these EPTS, documents issued by EASA must abide by a certain format (subparts, requirements, MoC and IM) which diverts from that of Volume I of Annex 16. Since both texts (Volume I of Annex 16, and the EPTS) have quite different arrangements, cross-referencing Annex 16 from the EPTS would result in excessive text additions.
comment	*10* comment by: *DGAC* The EPTS proposed by EASA for VTOL-capable aircraft powered by tilting rotors defines very clear procedures with exhaustive details on all aspects of the measurement from the implementation of sensors to data signal processing. An excellent work.
response	Noted. Thank you for your positive comment.
comment	*11* comment by: *DGAC* The specifications is based on Chapter 13 of the ICAO Annex 16 Volume I, with the additional hover flight condition. We fully support the hover conditions which will be representative of some specific operations.
response	Noted. Thank you for your positive comment.
comment	*12* comment by: *DGAC* The full procedure may be considered as very heavy to be implemented with five different flight conditions: take-off, approach, overflight aeroplane mode, overflight conversion mode and hover. However, EASA's choice is justified by the current uncertainties about the noisiest operating conditions and the differences of aircraft design.

response

Noted.
Thank you for your positive comment. This is indeed the rationale that was followed when establishing these EPTS.

comment

30 comment by: *Craig Mead*

Vertical Aerospace supports the intent of this proposed EPTS to establish a consistent set of rules against which VTOL-Capable Aircraft (VCA) can be certified for noise. There is currently a proliferation of VCAs in development worldwide. Many of these have novel architectures which will require multiple concessions to fit them to the categories and procedures in the current legislation. This potentially leads to VCAs being certified using significantly different procedures, which could lead to unfair comparison between different aircraft. A consistent set of generally-applicable procedures and associated noise limits is urgently needed to prevent this.

response

Noted.
Thank you for your comment. The objective of these EPTS is precisely to address this issue and provide a set of noise measurement procedures and limits to the designs fulfilling the applicability criteria.

comment

31 comment by: *FOCA (Switzerland)*

Thank you for the opportunity to comment.
FOCA welcomes EASA's intention to align the measurement specifications on an internationally harmonised baseline (ICAO Annex 16, Volume 1, Chapter 13). Nevertheless, the certification will be a major challenge for Start-ups and other small drone industries. It is to be expected that there are only a few providers worldwide who can provide such certification, and the costs involved are likely to be considerable. Such a situation will significantly increase the market entry barriers for drone manufacturers and operators and slow down the growh of the young and very innovative European drone market. Such a situation may contrasts with the objective to "unleash the growth potential of drones" set by the EU Commission Drone Strategy 2.0 (p. 3).
Thank you for taking note and kind regards.

response

Noted.
Thank you for your comment. We fully appreciate the point you are making regarding the proportionality of these EPTS to the designs under consideration. We nevertheless need to clarify that, although there is no lower weight limit specified in the applicability scope of these EPTS, they are not intended to be used for "small unmanned drones" which are already covered, to some extent, by EASA's Guidelines for the noise measurement of drones of the 'specific' category lighter than 600 kg.
EASA considers the noise procedures delineated in these EPTS to be proportionate to the targeted designs, which would typically be air taxis (Urban Air Mobility). Moreover, EASA considers that using noise measurement procedures similar to those of legacy chapters of ICAO Annex 16 Volume I (here, Chapter 13 for tiltrotors) enables an easy comparison with those conventional designs.

comment	*39* comment by: *The Boeing Company* Attachment #2
response	Noted. Thank you for your contribution. We can see that the individual comments contained within this attachment are all showing separately further in this document. They are therefore addressed individually.

comment	*45* comment by: *DE-LBA* LBA has no comments and welcomes the implementation of the environmental protection technical specifications.
response	Noted. Thank you for your feedback, which does not need addressing.

comment	*46* comment by: *UECNA* Date: 9 Feb 2024 First of all, UECNA would like to express its appreciation for the opportunity to comment on EASA intentions with respect to assessing environmental compatibility of VTOL-capable aircraft powered by tilting rotors. We would like to offer the following comments: 1. Annex III of the Basic regulation (Reg. 2018/1139) states that products must be designed to minimize noise as far as possible. The ID_803 file is presented as a first step for the Agency to establish detailed environmental requirements to that end. We note that this process can not delay, nor deviate from, the obligation of the design organization to minimize noise as far as possible. The burden of proof is on the applicant and the role of EASA is to judge this. We have great concerns about the suggestion that stems form the proposal that the design would only have to meet the requirements that are applicable to helicopters (Chapter 8.4.2 of ICAO Annex 16). As EASA states, the expectation is that these aircraft would have a (much?) lower noise signature than helicopters. It is thus not acceptable to suggest that merely meeting the standards for helicopters would be sufficient to approve the design for noise. 2. We think that operations of these vehicles will be a significant source of noise annoyance and as such will be a threat to health and well being of EU citizens. We count on EASA to help protect EU citizens, in particular where an EU wide approach would be the most efficient way of dealing with the problem. In our opinion operating limitations will be needed to restrict the use of these new forms of aviation. As is the case with other aircraft, there is a role for EASA to facilitate the assessment of noise from these aircraft. We think that in particular EASA should assess the noise and performance characteristics of these aircraft and make them available for noise assessments. This along the same lines as it does for large aircraft per Article 7 of the Balanced Approach regulation (Reg 598/2014). We also think EASA should take the lead in developing such noise assessment methodology, for instance by building further on the valuable work it has done on helicopters, in the research project on rotorcraft noise (https://www.easa.europa.eu/en/research-projects/environmental-research-rotorcraft-noise). We note that we could have made these comments earlier, when the EASA proposed Environmental Protection Technical Specifications applicable to eVTOL powered by

multiple vertical, non-tilting evenly distributed rotors was up for comments (ID_463). Unfortunately, we were not aware of this publication. We hope nevertheless that our above comments will still be taken into account when EASA is dealing with applications for type design approval.

John Stewart, Chair UECNA

response

Noted.
Thank you for your comment, and for contributing to the effort of the current EPTS despite not having been able to for the previous EPTS for VCA with non-tilting rotors.
Regarding comment #1, we take good note of your point. The noise limits of Chapter 8 of Annex 16, Volume I currently serve as a starting point given the current limited VCA noise data available to EASA.
As for comment #2, these EPTS address the topic of noise assessment and limitation at the design level (equivalent to the first pillar of the ICAO Balanced Approach). While EASA anticipates that the noise levels resulting from these EPTS may be used to inform local operations, the EPTS are not intended to address all aspects of noise annoyance at a local scale. Nevertheless, the Agency is conducting measurement test campaigns within the scope of the research project NORAH, one of the objectives being to obtain noise signatures of novel vehicles (UAS and VCA) in all directions (hemispheres). This dataset will be made available to the public and local authorities (national, regional, municipal) should they need to regulate noise at a local scale.

comment

51 comment by: *Federal Aviation Administration*

FAA comment on Introductory Note: In paragraph 4, beginning "The following EPTS are proposed for aircraft…," FAA recommends clarifying whether this rule is for aircraft that use exclusively tilting rotors or whether they can have a mix of fixed rotors and propellers as well.

response

Accepted.
Thank you for your comment. EASA will clarify the applicability scope in the final version of the EPTS to VCA powered partially or exclusively by tilting rotors.

NVTOL-TILT.1000 - Applicability p. 7

comment

17 comment by: *Craig Mead*

It is not made explicit in the text whether the EPTS is applicable to VCAs having *only* tiltable rotors, or whether it is also applicable to VCAs having a combination of tiltable and non-tiltable rotors. Please clarify the intended application.

response

Accepted.
Thank you for your comment. EASA will clarify the applicability scope in the final version of the EPTS to VCA powered partially or exclusively by tilting rotors.

NVTOL-TILT.1005 - Definitions p. 7

comment 40 — comment by: *The Boeing Company*

COMMENT #1			
Type of comment (check one)	***Non-Concur***	***Substantive*** X	***Editorial***
Affected paragraph and page number	Page:7 Paragraph: *NVTOL-TILT.1005*		
What is your concern and what do you want changed in this paragraph?	**THE PROPOSED TEXT STATES:** These Environmental Protection Technical Specifications apply to VTOL-capable aircraft (VCA) powered by rotors mounted on tiltable axes, where a VCA is defined as a power-driven, heavier-than-air aircraft, other than aeroplane or rotorcraft, capable of performing vertical take-off and landing by means of lift and thrust units used to provide lift during take-off and landing. **REQUESTED CHANGE:** These Environmental Protection Technical Specifications apply to VTOL-capable aircraft (VCA) powered **by distributed** rotors**, partially or exclusively,** mounted on tiltable axes, where a VCA is defined as a power-driven, heavier-than-air aircraft, other than aeroplane, rotorcraft**, or tilt-rotor,** capable of performing vertical take-off and landing by means of lift and thrust units used to provide lift during take-off and landing.		
Why is your suggested change justified?	**JUSTIFICATION:** The EPTS should include the applicability to aircraft powered by both tilting- and non-tilting rotors. For example, an aircraft may have several rotors, some of which are be non-tilting to provide lift for takeoff and landing, and some tilting rotors used for generating both lift and thrust. These types of aircraft may best fall under this EPTS. Additional clarification on this point is needed, as there are multiple potential applicants that have aircraft architecture described in the aforementioned example. Further, an aircraft design that is capable of VTOL with tilting rotors could have applicability in both this EPTS and ICAO Annex 16, Vol. 1, Chapter 13. Boeing recommends EASA expand on when an aircraft is applicable to this EPTS versus to ICAO Annex 16, Vol. 1, Chapter 13.		

response

Partially accepted.
Thank you for your comment and suggested edits. EASA will adopt your suggestions in the final version of the EPTS, except for the term "distributed" which, although generally understood, is not officially defined in the EASA rules.

comment 52 — comment by: *Federal Aviation Administration*

FAA comment: Regarding the definition of "V_MCP," the FAA recommends clarifying minimum engine for eVTOL if possible, or whether it is still needed for eVTOL.

response

Accepted.
Thank you for your comment. We will remove the mention of "minimum engine" from the definition of V_{MCP} in the final version of these EPTS.

SUBPART B - NOISE EVALUATION METRICS p. 8

comment

2 comment by: *Ulf Tengzelius*

Attachment #3

TWO MAYOR CONCERNS:

1. The stated lower frequency, 50Hz, in frequency bands to be studied as of the EPTS (noise) for VTOLs is not enough low - fundamental BPF for vehicles already flying is found to be as low as ca 20 Hz
(see Joby data level flight figure 6 in: https://ntrs.nasa.gov/api/citations/20220006729/downloads/Aeroacoustics2022_Pascioni_STRIVES5.pdf)
which implies that the freq. band of concern has to be extended from 50 Hz to lower frequencies!

This point 1 is clarified in an attachment and relates to all paragraphs were the lower frequency to be studied is stated as 50 Hz

2. I believe that for future VTOL vehicles the EPNL metric, used for today's aircraft fleet certifications, would better be replaced with a more general, and informative metric involving frequency information. This could be a A-weighted sound pressure value, LpA, both total level and as a function of frequency, for given flight condition and directivity.
If it is decided not to include frequency information and focus on a integrated metric a better alternative than EPNL is in my opinion LAeq for all flight conditions, not only for hover as stated in SUBPART B - NOISE EVALUATION METRICS NVTOL-TILT.1100 - Applicable noise evaluation metrics.

This point 2 relates to all sections were EPNL is mentioned.

My motivation to point 2. "Include frequency information and use L_{Aeq} values rather than EPNL as ruling metric", follow below

The PNL and EPNL metrics were established the 1960s linked to the start of aircraft noise regulation. At that time, with the lack of computer power and digital data communication, one were stuck to very condensed/compact metrics and datasets, which is not the case any longer.

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From narrowband sound pressure data sets it would be possible to compute the value of almost any metric at a given distance and direction from the source for given flight conditions (hover, ascent at specified angle speed ... etc.). It could be Lp(t,f), A-weighted,

Lpmax, Sound Exposure Level, Leq, EPNL or some other metric than EPNL involving attempts to include a kind of subjective perception of sound.

It should be noted that the PNL/EPNL metrics are aimed and used solely for aircraft noise certification - i.e. in contrary to e.g. LpAmax or Leq, the EPNL is not used for any other kind of community noise. This situation complicates direct comparisons between aircraft and other sound sources where one is defined in EPNL and the other in e.g. LAmax. Moreover, the EPNL is neither, at least not anywhere in Europe as of my knowledge, used as a guideline or limit value even for air traffic noise on ground. My view is that the proposed EPNL metric risks, in a completely unnecessary way, to "blur" the evaluation process for VTOLs as sound sources, not only for common people, but also for professionals.

Regarding the expressed need for frequency information it can be worth to emphasise that without having access to the frequency spectrum a direct transformation of PNL or EPNL to more widely used metrics like Sound Pressure Level ("linear" or A-weighted) or SEL (Sound Exposure Level), or vice versa, is not possible.

Such an access to vehicle noise data including frequency information set as requirement on the industry would enable more general and accurate information to the public and the society as a whole and giving the possibility to generate better noise-mapping and -mitigation, potentially support health. Such a demand on stronger transparency from the industry with regard to noise specifications would most likely not introduce any additional costs compared with a more limited EPNL data set.

response

Noted.
This comment has already been addressed in this document (c.f. Comment #1).

NVTOL-TILT.1100 - Applicable noise evaluation metrics p. 8

comment

4 comment by: *UK CAA*

Page No: 8

Paragraph No: NVTOL-TILT.1100 – Applicable noise evaluation metrics

Comment: The UK CAA believes limiting the noise metric to EPNL for the evaluation of take-off, flyover and approach noise, misses an opportunity to acquire other noise metrics for future standard development, such as SEL (A and possibly D weighted). It is recommended to require that noise levels in SEL, in addition to EPNL, be evaluated and reported on.

Justification: The acquisition of additional data can inform future standard development, particularly a less expensive, simpler standard more appropriate to lighter aircraft, similar to Chapter 11 applicable for light helicopters.

response

Partially accepted.
Although we are not aiming to follow the same path as helicopter noise certification (a "simpler" scheme like Chapter 11 of Annex 16 Volume I for lighter designs), we believe that the provisions of NVTOL-TILT.1410 (a)(2), which recommends that the acoustic signals be "recorded and

stored for subsequent analysis", leave the possibility to use different metrics than EPNL in the future, where an applicant could easily re-process their noise data should the need arise. However, we will also add "the values of the measured A-weighted Sound Exposure Level (SEL), if available to the applicant" as data to be reported for each run in NVTOL-TILT.1710 ("Additional Test Information").

NVTOL-TILT.1105 - Calculation of Effective Perceived Noise Level p. 8

comment *32* comment by: *Leonardo Helicopters*

Comments: *The definition of V_{MCP} misses the precision "in level flight" compared to that of ICAO Annex 16 Volume I Chapter 1.1*
Suggested Resolution: "*The definition of V_{MCP} should precise "in level flight"*
Level: M

response Accepted.
Thank you for your comment. We will update the definition of V_{MCP} accordingly in the final version of the EPTS.

comment *33* comment by: *Leonardo Helicopters*

Comment: *V_Y and BROC are not required to be reported in the RFM.*
Suggested resolution: *Add V_Y and BROC to be reported in the RFM (or indicate whether the reporting is asked by another rule - e.g. SC-VTOL).*

Level: M

response Accepted.
Thank you for your comment which also triggered us to add the definitions of V_Y and "best rate of climb" into the Definitions section of the final EPTS (they had been forgotten). V_Y and "best rate of climb" values will need to be reported in the approved flight manual. This will be reflected into the final EPTS.

IM1 NVTOL-TILT.1200 - Reference noise measurement points p. 16

comment *5* comment by: *UK CAA*

Page No: 16

Paragraph No: IM1 NVTOL-TILT.1200 - Reference noise measurement points - HOVER REFERENCE NOISE MEASUREMENT POINT

Comment: An array of 9 reference noise measurement points is defined for the hover reference procedure. ICAO has previously acknowledged that difficulties in the measurement of hover noise for helicopters make it poorly suited for certification purposes, in particular due to the high sensitivity to wind

conditions leading to limited repeatability of test results. In addition, ICAO has acknowledged that hover conditions for helicopters might be reasonably correlated with certification take-off, due to the fact that both conditions are characterised by high main rotor thrust (see Helicopter Noise Reduction Technology, Status Report, 21 April 2015).

Given the possible wide variability of measured hover results and the present lack of specified maximum allowable noise levels for the hover condition, the UK CAA believes the justification for specifying an additional hover procedure in the EPTS document remains unclear.

Justification: Clarity required on (i) the rationale for requiring the additional complexity (and therefore cost) of a multiple microphone array.

Proposed Text: n/a

response

Noted.
Thank you for your comment. First, even if the default setup at hover consists of nine microphones, IM1 NVTOL-TILT.1200 allows an alternative setup with only three aligned microphones by rotating the vehicle by steps of 90° heading. Since the other noise procedures already require 3 microphones, and since applicants may also use additional microphones mounted inverted over ground plates to identify pseudotones, the hover measurement could effectively be performed without additional equipment as for the other points.
While ICAO CAEP may have acknowledged that helicopter hover correlates reasonably with other procedures of noise certification, we do not know if that is the case for VCA as we have a very limited amount of noise data available. We want to avoid a situation where specific annoying noise phenomena would occur in this phase and not be captured by the other three points. The consideration of an introduction of a regulatory limit for hover might be reopened in the future upon collecting sufficient noise data.

NVTOL-TILT.1205 - Reference procedures p. 18

comment *6* comment by: *UK CAA*

Page No: 18

Paragraph No: NVTOL-TILT.1205 - Reference procedures

Comment: Referring to “the “centre of the smallest enclosing circle” as defined in Subpart B, MOC VTOL.2105, Section 8 of the Second Publication of Proposed Means of Compliance with the Special Condition VTOL” the UK CAA believes this could make it very difficult to understand.

Justification: Improved clarity.

Proposed Text: Reproduce in full the definition in Subpart B, MOC VTOL.2105, Section 8.

response

Partially accepted.
Thank you for your comment. The definition of "centre of the smallest enclosing circle" is already almost fully reproduced from Subpart B, MOC VTOL.2105, Section 8. There is no additional information from Section 6 ("Dimension "D"") nor Section 8 ("Centre of the smallest enclosing circle") that can be used in the current EPTS. Nevertheless, for completeness, we will add the mention "with rotor(s) turning if applicable" to the existing sentence in the final EPTS version.

comment

7 comment by: *UK CAA*

Page No: 20

Paragraph No: NVTOL-TILT.1205 (g) - Reference procedures

Comment: Each of the take-off, overflight and approach reference procedures require that the aircraft is stabilised throughout. The EPTS acknowledges that with the agreement of the Agency departures "from the reference procedures to the extent demanded by those design characteristics which make satisfying the reference procedures impossible" may be allowed. It is quite likely that the FMS does not allow stabilisation. The UK CAA recommends EASA to expand this paragraph to give examples of what departures are envisaged and therefor may be allowed.

Justification: Clarity and more consistent implementation.

response

Not accepted.
Thank you for your comment.
First, as a reminder, the reference procedures described in NVTOL-TILT.1205 (g) require no wind and constant temperature and relative humidity conditions. Therefore, the conditions are deterministic and will allow the applicant to determine the corresponding reference profile based, amongst other things, on the knowledge of the FMS behaviour. Additionally, without having collected data through specific projects, we are not presently in a position to suggest or quantify typical allowable deviations from the specifications of reference procedures. These EPTS need to cover all possible designs of VCA powered, at least partially, by tilting rotors. As such, the provisions of NVTOL-TILT.1205 (g) will allow the necessary case-by-case adaptations.

comment

13 comment by: *DGAC*

(b)(1)
Why not using the horizontal position of centre of gravity as in vertical direction? The approach based on the circle enclosing the aircraft would be a good alternative if the centre of gravity is difficult to define in detail. But, as it is used in the vertical plane, it maybe better in the horizontal plane too.

response

Not accepted.
Thank you for your comment. While we have been considering the centre of gravity for the horizontal position as well, we realized that, according to the configuration to be certified for noise, it could vary quite a lot on the horizontal plane (especially between manned and unmanned configurations), while staying rather stable on the vertical plane. The

	centre of the circle enclosing the aircraft was therefore chosen as the most practical option.
comment	*14* comment by: *DGAC* (c)(2) Even if the use of battery prevent the weight loss as with classic fuel, it might occur an evolution of the performance with time during the full process. Is it possible to mitigate this risk? Not easy to answer with a small number of experiences.
response	Noted. Thank you for your comment. Since this specification relates to the reference procedures (which are therefore deterministic and expected to be calculated by the applicant), there is by default no accounting for battery performance degrading over time. The noise profiles corresponding to these procedures assume batteries in full state of health. We will add this mention to the final EPTS. Note that it does not mean that the batteries used for the test must meet those requirements (the test procedures – NVTOL-TILT.1405 – do not specify any battery performance).
comment	*15* comment by: *DGAC* (c)(4) "Maximum Take-Off Mass (MTOM)": to define the acronym, even if it is well known.
response	Accepted. Thank you for your comment. The acronym will be added to the Definitions section in the final EPTS.
comment	*16* comment by: *DGAC* (h) Typo "angles"
response	Accepted. Thank you for your comment. The typo will be corrected in the final EPTS.
comment	*18* comment by: *Craig Mead* **Paragraph (c) [Take-off]** There is no guidance in the EPTS as to how the nacelle angle should be selected. IM for conventional tilt rotors in Doc 9501 suggests that the nacelle angle should be that (or close to that) which would achieve the best overall rate of climb. If that is the intent, then we suggest including that as IM in the EPTS.
response	Partially accepted. Thank you for your comment and suggestion. We will add an IM with the corresponding content in the final version of the EPTS. However, unlike in Chapter 13 of Volume I of ICAO Annex 16, the intent is not to leave full flexibility to the applicant to choose the nacelle angle that only meets the specifications of best rate of climb, but also to choose the one that corresponds to the noisiest configuration while still meeting the best rate of climb.

comment	*20* comment by: *Craig Mead* **Paragraph (c) [Take-off]** The overall best-rate-of-climb speed for some eVTOL configurations is likely to be in fully-wingborne flight. Is it the intent of the authority to allow the take-off procedure to be flown fully wingborne? If not, then a further limitation on the airspeed (e.g. <0.7 VFTO) may be needed.
response	Not accepted. Thank you for your comment and suggestion. While subparagraph (c)(3) demands a climb at the minimum between "V_y or lowest approved speed for climb after take-off", subparagraph (h) requests, amongst other parameters, that the nacelle angle corresponding to the noisiest configuration, while still meeting the specifications of (c), be used.

comment	*21* comment by: *Craig Mead* **Paragraph (c) [Take-off]** The nacelle angle on eVTOLs is likely NOT to be directly controlled by the pilot. Rather, it is likely to be controlled by the Flight Control System and will be a consequence of the aircraft state, including airspeed and climb rate, and may react to dynamic events such as gusts. Maintenance of the nacelle at a fixed angle is likely to be impossible. Given that nacelle angle for new aircraft probably cannot be held fixed, and that best-rate-of-climb speed may be in the wingborne configuration, it is probable that some sort of concession will be required for many/most applicants. This potentially leads to inconsistent results depending on the interpretation/concessions applied to each application. Given this, it may be better to define a more generally applicable take-off procedure. For example, the reference takeoff procedure could be defined as that which results when the pilot commands maximum rate of climb at a fixed speed, such as, say, 0.7 VFTO.
response	Not accepted. Thank you for your comment and suggestions. We must however mention that the reference take-off procedure is considered in stable weather conditions, including zero-wind, making them deterministic (and not subject to wind gusts). If, for a particular design, the Flight Control System (FCS) cannot maintain a fixed nacelle angle throughout the 10 dB downpoint, the resulting evolution of nacelle angle against time would still be deterministic. This aspect would be discussed between applicant and Agency on a project basis. Setting a general rule (e.g.: limiting the speed below 0.7 x V_{FTO} as suggested) is premature at this stage without collecting more experience through projects.

comment	*22* comment by: *Craig Mead* **Paragraph (d).(2) [Overflight in VTOL mode]** The nacelle angle on eVTOLs is likely NOT to be directly controlled by the pilot. Rather, it is likely to be controlled by the Flight Control System and will be a

consequence of the aircraft state, including airspeed. Attempting to fly at 0.9 VCON, where VCON is a function of nacelle angle, will likely result in the Flight Control System trimming the aircraft by adjusting the nacelle to a different angle. The overflight/VTOL procedure prescribed in the EPTS is therefore likely to be impossible to achieve.

We therefore recommend that an alternative speed be selected which should be achievable by the majority of applicants, such as, say, 0.7 VFTO.

response

Partially accepted.
Thank you for your comment and suggestion. Setting a general rule (e.g.: limiting the speed below 0.7 x V_{FTO} as suggested) is premature at this stage without collecting more experience through projects. Nevertheless, we will add the condition for the Overflight procedure in VTOL/Conversion mode to maintain "a speed of 0.9 VCON, or the highest speed possible with stabilized nacelle angle, whichever is smaller" in the final EPTS.

comment *23* comment by: *Craig Mead*

Paragraph (e) [Approach]
There is no guidance in the EPTS as to how the nacelle angle should be selected. IM for conventional tilt rotors in Doc 9501 suggests that the nacelle angle should be that for which the approach is noisiest. If that is the intent, then we suggest including that as IM in the EPTS.

response

Not accepted.
Thank you for your comment. However, this requirement is already present in paragraph (h) of NVTOL-TILT.1205 ("For all reference procedures specified in "(c)", "(d)", "(e)", and "(f)", if the design allows for combinations of different rpm values between rotors, **nacelle angles**, aircraft attitudes, control surfaces, or external appendages, whilst satisfying the requirements set forth in "(c)", "(d)", "(e)", and "(f)", **the noisiest configuration** must be identified and agreed with the Agency")

comment *24* comment by: *Craig Mead*

Paragraph (e) [Approach]
The nacelle angle on eVTOLs is likely NOT to be directly controlled by the pilot. Rather, it is likely to be controlled by the Flight Control System and will be a consequence of the aircraft state, including airspeed and climb rate.

The EPTS, as it stands, requires a -6° approach to be flown at a pre-defined (see comment above) nacelle angle, and at the best rate of climb speed which corresponds to that nacelle angle. However, it is unlikely that the Flight Control System will trim the nacelle to the targeted angle when the aircraft is at the targeted speed, or vice versa. The proposed combination of a particular nacelle angle and its corresponding best rate of climb speed is therefore likely to be impossible to achieve. As a consequence, it is likely that some sort of concession will be required for many/most applicants. This potentially leads to inconsistent results depending on the interpretation in each case.

Given this limitation, we suggest that the approach procedure be redefined to be more generally applicable. For example, the approach could be performed at an appropriate fixed speed, such as 0.7 VFTO.

response

Not accepted.
Thank you for your comment and suggestion. As for the other procedures, this aspect would be discussed between applicant and Agency on a project basis. Setting a general rule (e.g.: limiting the speed below 0.7 x V_{FTO} as suggested) is premature at this stage without collecting more experience through projects.

comment

25 comment by: *Craig Mead*

Paragraph (f) [Hover]
The purpose of this measurement is unclear. How is the data expected to be used? eVTOLs are unlikely to spend much, if any, time hovering out of ground effect, as it is a very energy intensive exercise. If the purpose is to quantify noise around vertiports, then measurements of noise directly below the aircraft do not seem to have a purpose. It might make more sense if the hover height was lower and the measurements were further away from the aircraft laterally, where observers might be present in real operations.

response

Not accepted.
Thank you for your proposal. The intent of adding the reporting requirement for the Hover point is not only to assist local authorities in monitoring noise close to where eVTOL will operate (including possibly vertiports), but also to obtain the noise signature in a particular phase of the flight that might not otherwise be captured through the other three measurement points inherited from Chapter 8 of Annex 16, Volume I. You can also note that the current hover procedure foresees directivity angles of 30° and 60° which, while not capturing pure lateral directivity (90°), would still provide more information than "directly below the aircraft" as your comment indicates. If the design prevents the procedure to be flown as per the specifications of these EPTS, the provisions of paragraph (g) of NVTOL-TILT.1205 or paragraph (g) of NVTOL-TILT.1405 may be used on a case-by-case basis.

comment

26 comment by: *Craig Mead*

Paragraph (f) [Hover]
The hover procedure is very energy intensive. With the requirement to fly out and back into the box between measurements, it is possible that this procedure alone could take several days of flight testing. This seems excessive given the unclear purpose of the measurement.

response

Noted.
Thank you for your comment. Please refer to our answer to Comment #25 regarding the purpose of the Hover noise reporting requirement.
As for the practicality of executing the hover test procedure of paragraph (f) of NVTOL-TILT.1405, the provisions of paragraph (g) of NVTOL-TILT.1205 or paragraph (g) might constitute a basis for possible discussions if the design prevents the test procedures to be exactly carried out as specified.

comment	*27* comment by: *Craig Mead* **Paragraph (f) [Hover]** Specifying both hover height and 'at MTOM' is potentially contradictory to performance regulation of SC-VTOL that requires the applicant to establish hover heights in departure/approach procedures i.e. it could imply testing outside of the boundaries established for continued safe flight and landing.
response	Noted. Thank you for your comment. Although EASA does not see a direct contradiction with SC VTOL.2105, the provisions of paragraph (g) of NVTOL-TILT.1205 or paragraph (g) of NVTOL-TILT.1405 nevertheless serve to deviate from the reference and/or test procedures as necessary by the design or out of safety reasons. This deviation can be agreed upon with the Agency on a case-by-case basis.
comment	*28* comment by: *Craig Mead* **Paragraph (f) [Hover]** NVTOL-TILT.1200(d) and NVTOL-TILT.1205(f) require the aircraft to be directly above the central microphone, and NVTOL-TILT.1405(f)(5) requires that 'the downwash of the aircraft cannot impinge the microphones'. It is not obvious that, in a quiescent atmosphere, a microphone placed directly below the aircraft will be completely out of the downwash even at 50 m altitude. The rule of thumb of 3 x rotor diameters for downwash from a helicopter is to avoid high-speed flow with potentially damaging effects and does not preclude impingement of lower-speed flow on the microphones. We recommend that either: 1. the microphones be moved further away from the aircraft laterally, or 2. a maximum permissible windspeed (combination of induced + ambient winds) on the ground below the aircraft be allocated, above which measurements might be eliminated without penalty.
response	Accepted. Thank you for your comment and associated suggestions. EASA will incorporate your second suggestion into the final EPTS as a MoC. A limit of 5 knots instant windspeed (combination of induced and ambient wind speeds) will be specified in the vicinity of the central microphone of the hover test setup (within 1 m, at a height between 1 and 2 m). However, since this setup would not satisfy the absence of obstacle within the 80° cone around the central microphone (paragraph (f) of NVTOL-TILT.1400), this measurement will need to take place during trial runs (not to be taken credit for hover noise points), during which the VCA will set itself on condition at target height condition. The target height might therefore need adapting based on the detection of downwash during these trial runs.
comment	*34* comment by: *Leonardo Helicopters* **Paragraph:** *NVTOL-TILT.1205(c)(3)* **Comment:** *The proposed rule does not specify any nacelle angle - which is consistent with ICAO Annex 16 Volume I Chapter 13 for tilt-rotors. The*

applicant shall maintain that nacelle angle throughout the reference procedure, and the reference speed is defined in relation to this angle. Shall the angle be declared in advance to the Authority, or the actually flown angle simply reported after the tests?

Suggested resolution: *Specify the conditions for the choice of nacelle angle for take-off.*

Level H

response

Not accepted.
Thank you for your comment. While it is correct that paragraph (c)(3) of NVTOL-TILT.1205 only refers to one nacelle angle, paragraph (h) also requires to identify the value of nacelle angle (amongst other parameters) that would trigger the noisiest configuration. Therefore, if several values of nacelle angles satisfy the requirements of paragraph (c)(3), the most critical for noise will need to be identified and used during the test.

comment *53* comment by: *Federal Aviation Administration*

FAA comment: regarding subsection (c)(2), the FAA recommends clarifying that the batteries should be at a state of charge sufficient to allow the BOC performance, rather than the currently specified "maximum state of charge" which only exists right after the charge cord is pulled out.

response

Not accepted.
Thank you for your comment. The specification of batteries at maximum State of Charge applies to the reference procedures, not the test procedures. As such, they constitute an assumption for the applicant to be calculating the corresponding "virtual" flight profile to which the noise acquired from the test procedures will be adjusted.

SUBPART D - MAXIMUM ALLOWABLE NOISE LEVELS p. 21

comment *8* comment by: *UK CAA*

Page No: 21

Paragraph No: SUBPART D – MAXIMUM ALLOWABLE NOISE LEVELS

Comment: The EPTS is based on Chapter 13 of the Annex. Chapter 13 does not apply any maximum allowable noise levels for overflight in aeroplane mode, whereas the EPTS prescribes the same limits applied to overflight in VTOL/Conversion mode. The UK CAA asks what basis are these limits appropriate?

response

Noted.
Thank you for your question. For overflight in aeroplane mode, EASA decided to prescribe and use the same noise limits as for the VTOL/conversion mode. Aeroplane mode is expected to result in quieter noise signatures than VTOL/conversion mode for the majority of VCA designs, therefore meeting the same noise limits is not expected to cause any issues. Upon collecting sufficient data at overflight in aeroplane mode, these noise limits might later get revised.

comment	*54* comment by: *Federal Aviation Administration* FAA comment: FAA notes that levels in this section should match Chapter 13 levels.
response	Not accepted. Thank you for your comment. While these EPTS were built from the legacy procedures of Chapter 13 of ICAO Annex 16, Volume I, EASA deliberately used the same noise limits as the other EPTS for VCA with non-tilting rotors to ensure a level-playing field within VCA designs.

IM1 SUBPART D Maximum Allowable Noise Levels p. 21

comment *41* comment by: *The Boeing Company*

COMMENT #2			
Type of comment (check one)	***Non-Concur***	***Substantive*** ***X***	***Editorial***
Affected paragraph and page number	Page: 21 Paragraph: *Subpart D, IM1 Subpart D*		
What is your concern and what do you want changed in this paragraph?	**THE PROPOSED TEXT STATES:** For the take-off reference procedure, the maximum value for $EPNL_{TOref}$, specified in paragraph "(c)(1)" of "NVTOL-TILT.1605 - Satisfying maximum allowable noise levels", is set at 106 EPNdB for the aircraft with maximum certificated take-off mass of 80,000 kg and over, and decreasing linearly with the base-10 logarithm of the aircraft maximum certificated take-off mass at a rate of 3 EPNdB per halving of mass down to 86 EPNdB, after which the limit is constant. For the overflight reference procedures, both in VTOL/conversion and aeroplane modes, the maximum value of $EPNL_{OVconv,ref}$ and $EPNL_{OVaero,ref}$, specified in paragraph "(d)(1)" of "NVTOL-TILT.1605 - Satisfying maximum allowable noise levels", is set at 104 EPNdB for the aircraft with maximum certificated take-off mass of 80,000 kg and over, and decreasing linearly with the base-10 logarithm of the aircraft maximum certificated take-off mass at a rate of 3 EPNdB per halving of mass down to 84 EPNdB, after which the limit is constant. For the approach reference procedure, the maximum value of $EPNL_{APref}$, specified in paragraph "(f)(1)" of "NVTOL-TILT.1605 - Satisfying maximum allowable noise levels", is set at 109 EPNdB for the aircraft with maximum certificated take-off mass of 80,000 kg and over, and decreasing linearly with the base-10 logarithm of the aircraft maximum certificated take-off mass at a rate of 3 EPNdB per halving of mass down to 89 EPNdB, after which the limit is constant. **REQUESTED CHANGE:** For the take-off reference procedure, the maximum value for $EPNL_{TOref}$, specified in paragraph "(c)(1)" of "NVTOL-TILT.1605 - Satisfying maximum allowable noise levels", is set at ~~106~~ 109 EPNdB for the aircraft with maximum certificated take-off mass of 80,000 kg and over, and decreasing linearly with the base-10 logarithm of the aircraft maximum certificated take-off mass at a	

	rate of 3 EPNdB per halving of mass down to ~~86~~ **89** EPNdB, after which the limit is constant. For the overflight reference procedures, both in VTOL/conversion and aeroplane modes, the maximum value of $EPNL_{OVconv,ref}$ and $EPNL_{OVaero,ref}$, specified in paragraph "(d)(1)" of "NVTOL-TILT.1605 - Satisfying maximum allowable noise levels", is set at ~~104~~ **108** EPNdB for the aircraft with maximum certificated take-off mass of 80,000 kg and over, and decreasing linearly with the base-10 logarithm of the aircraft maximum certificated take-off mass at a rate of 3 EPNdB per halving of mass down to ~~84~~ **88** EPNdB, after which the limit is constant. For the approach reference procedure, the maximum value of $EPNL_{APref}$, specified in paragraph "(f)(1)" of "NVTOL-TILT.1605 - Satisfying maximum allowable noise levels", is set at ~~109~~ **110** EPNdB for the aircraft with maximum certificated take-off mass of 80,000 kg and over, and decreasing linearly with the base-10 logarithm of the aircraft maximum certificated take-off mass at a rate of 3 EPNdB per halving of mass down to ~~89~~ **90** EPNdB, after which the limit is constant.
Why is your suggested change justified?	**JUSTIFICATION:** For global harmonization Boeing recommends EASA maintain the noise limits found in ICAO Annex 16, Vol. 1, Chapter 13 and US 14 CFR Part 36 Appendix K to provide a consistent comparison between tilt-rotor aircraft, until such a time when enough data has been collected to set specific noise limits for this type of VCA powered by tilting rotors.

response

Not accepted.
Thank you for your comment and your elaborated proposal. While EASA gave due consideration to the arguments provided, our rationale supports the establishing of a level-playing field within VCA designs, which is why the noise limits of the current EPTS are identical to those for the VCA with non-tilting rotors.

comment *42* comment by: *The Boeing Company*

COMMENT #3			
Type of comment (check one)	***Non-Concur***	***Substantive*** ***X***	***Editorial***
Affected paragraph and page number	Page: 21 Paragraph: *Subpart D, IM1 Subpart D*		
What is your concern and what do you want changed in this paragraph?	**THE PROPOSED TEXT STATES:** For the take-off reference procedure, the maximum value for $EPNL_{TOref}$, specified in paragraph "(c)(1)" of "NVTOL-TILT.1605 - Satisfying maximum allowable noise levels", is set at 106 EPNdB for the aircraft with maximum certificated take-off mass of 80,000 kg and over, and decreasing linearly with the base-10 logarithm of the aircraft maximum certificated take-off mass at a rate of 3 EPNdB per halving of mass down to 86 EPNdB, after which the limit is constant. For the overflight reference procedures, both in VTOL/conversion and aeroplane modes, the maximum value of $EPNL_{OVconv,ref}$ and $EPNL_{OVaero,ref}$,		

	specified in paragraph "(d)(1)" of "NVTOL-TILT.1605 - Satisfying maximum allowable noise levels", is set at 104 EPNdB for the aircraft with maximum certificated take-off mass of 80,000 kg and over, and decreasing linearly with the base-10 logarithm of the aircraft maximum certificated take-off mass at a rate of 3 EPNdB per halving of mass down to 84 EPNdB, after which the limit is constant. For the approach reference procedure, the maximum value of $EPNL_{APref}$, specified in paragraph "(f)(1)" of "NVTOL-TILT.1605 - Satisfying maximum allowable noise levels", is set at 109 EPNdB for the aircraft with maximum certificated take-off mass of 80,000 kg and over, and decreasing linearly with the base-10 logarithm of the aircraft maximum certificated take-off mass at a rate of 3 EPNdB per halving of mass down to 89 EPNdB, after which the limit is constant. **REQUESTED CHANGE:** For the take-off reference procedure, the maximum value for $EPNL_{TOref}$, specified in paragraph "(c)(1)" of "NVTOL-TILT.1605 - Satisfying maximum allowable noise levels", is set at 106 EPNdB for the aircraft with maximum certificated take-off mass of 80,000 kg and over, and decreasing linearly with the base-10 logarithm of the aircraft maximum certificated take-off mass at a rate of 3 EPNdB per halving of mass down to 86 EPNdB, after which the limit is constant. For the overflight reference procedures, both in VTOL/conversion and aeroplane modes, the maximum value of $EPNL_{OVconv,ref}$ and $EPNL_{OVaero,ref}$, specified in paragraph "(d)(1)" of "NVTOL-TILT.1605 - Satisfying maximum allowable noise levels", is set at 104 EPNdB for the aircraft with maximum certificated take-off mass of 80,000 kg and over, and decreasing linearly with the base-10 logarithm of the aircraft maximum certificated take-off mass at a rate of 3 EPNdB per halving of mass down to 84 EPNdB, after which the limit is constant. For the approach reference procedure, the maximum value of $EPNL_{APref}$, specified in paragraph "(f)(1)" of "NVTOL-TILT.1605 - Satisfying maximum allowable noise levels", is set at 109 EPNdB for the aircraft with maximum certificated take-off mass of 80,000 kg and over, and decreasing linearly with the base-10 logarithm of the aircraft maximum certificated take-off mass at a rate of 3 EPNdB per halving of mass down to 89 EPNdB, after which the limit is constant. **Trade-offs** **If the maximum noise levels are exceeded at one or two measurement points:** **a) the sum of excesses shall not be greater than 4 EPNdB;** **b) any excess at any single point shall not be greater than 3 EPNdB; and** **c) any excess shall be offset by corresponding reductions at the other point or points.**
Why is your suggested change justified?	**JUSTIFICATION:** Trade-offs are not included in the EPTS, but are included in both ICAO Annex 16, Vol. 1, Chapter 8.5 and Chapter 13.5 for helicopters and tilt-rotors, respectively. Many of the VCA operate in a way in which the noisiest configuration is expected in the transition between airplane and helicopter mode. While these configurations are measured in the EPTS conditions, in operation, they will be transient and of short duration for energy management purposes. Removing the trade-offs from the EPTS could be harmful to potential applicants by penalizing the short duration transition before sufficient data exists to define specific procedures, even though the general noise signature of VCA is expected to be much lower than conventional aircraft.

	For global harmonization Boeing recommends EASA include the noise limit trade-offs from ICAO Annex 16, Vol. 1, Chapter 13 and US 14 CFR Part 36 Appendix K until sufficient data is collected from potential applicant vehicles to (a) determine new maximum noise limits, (b) evaluate the need for the trade-off provision.

response

Not accepted.
Thank you for your comment and your elaborated proposal. While EASA gave due consideration to the arguments provided, our rationale supports the establishing of a level-playing field within VCA designs, which is why no trade-offs are allowed in the current EPTS, in line with the EPTS for VCA with non-tilting rotors.

NVTOL-TILT.1400 - Test environment conditions p. 22

comment

55 comment by: *Federal Aviation Administration*

FAA comment: regarding subsection (j)(4), the FAA notes that the atmospheric absorption limit of 14 dB/100m could lead to a bifurcated measurement region assuming ARP866A is used across the measurement region. FAA recommends to make the limit in this subsection match Chapter 13 (i.e., 12 dB/100m).

response

Not accepted.
Thank you for your comment and suggestion. However, since subparagraph (i)(2) of NVTOL-TILT.1400 already specifies an accuracy of ±0.5°C for the temperature measurement, EASA consistently allows the possibility left by section 4.2.3.1.3 of ICAO's ETM to allow up to 14 dB/100 m absorption coefficient conditions at 8kHz (using SAE ARP866 model). Additionally, in light of the ongoing work within the ICAO CAEP WG1, the text of the EPTS will be edited to allow up to 16 dB/100m at the Approach point, as well as Hover.

NVTOL-TILT.1405 - Flight test procedures p. 26

comment

26 ❖ comment by: *Craig Mead*

Paragraph (f) [Hover]
The hover procedure is very energy intensive. With the requirement to fly out and back into the box between measurements, it is possible that this procedure alone could take several days of flight testing. This seems excessive given the unclear purpose of the measurement.

response

Noted.
This comment seems to be a repeat of an identical Comment #26, which is already addressed earlier in this document.

comment

27 ❖ comment by: *Craig Mead*

Paragraph (f) [Hover]
Specifying both hover height and 'at MTOM' is potentially contradictory to performance regulation of SC-VTOL that requires the applicant to establish hover heights in departure/approach procedures i.e. it could imply testing outside of the boundaries established for continued safe flight and landing.

response

Noted.
This comment seems to be a repeat of an identical Comment #27, which is already addressed earlier in this document.

comment

28 ❖ comment by: *Craig Mead*

Paragraph (f) [Hover]
NVTOL-TILT.1200(d) and NVTOL-TILT.1205(f) require the aircraft to be directly above the central microphone, and NVTOL-TILT.1405(f)(5) requires that 'the downwash of the aircraft cannot impinge the microphones'. It is not obvious that, in a quiescent atmosphere, a microphone placed directly below the aircraft will be completely out of the downwash even at 50 m altitude. The rule of thumb of 3 x rotor diameters for downwash from a helicopter is to avoid high-speed flow with potentially damaging effects, and does not preclude impingement of lower-speed flow on the microphones.

We recommend that either:
1. the microphones be moved further away from the aircraft laterally, or
2. a maximum permissible windspeed (combination of induced + ambient winds) on the ground below the aircraft be allocated, above which measurements might be eliminated without penalty.

response

Noted.
This comment seems to be a repeat of an identical Comment #28, which is already addressed earlier in this document.

comment

36 comment by: *Leonardo Helicopters*

Paragraph: NVTOL-TILT.1405(c)(4), (d)(4) & (e)(5)-

Comment:

The sentence misses an illustration or a precision, that it is about lateral deviation.

Suggested resolution: *Add a precision or an illustration (see ICAO Annex 16 Volume I Figure 8-1. Helicopter lateral deviation tolerances.*

Level: L

response

Accepted.
Thank you for your comment and suggestion. An illustration will be added as an additional Interpretation Material item in the final EPTS.

comment *37* comment by: *Leonardo Helicopters*

Paragraph: NVTOL-TILT.1405(c)(5), (d)(5) & (e)(6)

Comment: *The rpm tolerance of +/-3% is defined in relation to the average value, although NVTOL-TILT.1205(h) requires the definition of reference rpm values.*

Suggested resolution: *Specify a rpm tolerance in relationship with the reference rpm values*

Level: M

response

Not accepted.
Thank you for your comment. Although we recognize the merit in your point, we consider that the critical aspect to be captured by this specification is the stability of the rpm within the measured 10 dB downpoint. Test-day rpms might be the outcome of ambient conditions and Flight Control System, and therefore noticeably differ from reference rpms. The mandatory use of the Integrated method (NVTOL-TILT.1600) combined with adjustments for source correction possibly at every half-second within the 10 dB downpoints (subparagraph (b)(9) of NVTOL-TILT.1600) are expected to cater for such deviations.

comment *38* comment by: *Leonardo Helicopters*

Paragraph: NVTOL-TILT.1405(f)(1)

Comment: *The sentence does not include the term "valid". This would mean that the certification could be achieved even though all six runs would be invalidated.*

Suggested resolution: *Reformulate to: " a minimum of six valid runs should be performed;"*

Level: L

response

Accepted.
Thank you for your comment and suggestion, which will be incorporated into the final version of the EPTS.

comment *47* comment by: *Nico/Anotec*

d(3) "prior to the execution of each overflight procedure" should be "prior to the execution of **the** overflight procedure"

response

Partially accepted.
Thank you for your comment. The intent of this specification was actually "prior to the execution of each overflight procedure (VTOL/conversion mode and aeroplane mode)". The text will be amended accordingly in the final EPTS.

IM1 NVTOL-TILT.1400 - Test environment conditions p. 26

comment

35 comment by: *Leonardo Helicopters*

Paragraph: *NVTOL-TILT.1400(g)(1) & (j)(2)-(3)*

Comment *The proposed rule requests only to measure temperature and humidity at 10m above ground, while setting limits for these parameters between 10m above ground and the aircraft. Compliance with NVTOL-TILT.1400(j)(7) also requires knowledge of the temperature at the aircraft.*

Suggested resolution	*Clarify whether temperature and humidity shall be measured at the aircraft or assumed constant between ground and aircraft.*

Level H

response

Accepted.
Thank you for your comment and for pointing out this inconsistency. In line with the legacy procedures of Chapter 13 of ICAO Annex 16, Volume I (tiltrotors), the conditions on temperature and relative humidity are set only at 10 m above the ground. This will be reflected in the final version of the EPTS.

MoC1 NVTOL-TILT.1405 - Flight test procedures p. 28

comment

56 comment by: *Federal Aviation Administration*

FAA comment: regarding subsection (c)(5), FAA notes that this requirement is restrictive, if possible at all, for VTOL.

response

Noted.
Thank you for your comment. This specification aims at ensuring a minimum amount of rpm stability within the measured 10 dB downpoint.

If a given design cannot satisfy this condition, a deviation might be agreed by EASA, as per subparagraph (g) of NVTOL-TILT.1405.

IM3 NVTOL-TILT.1405 - Flight test procedures p. 32

comment *43* comment by: *The Boeing Company*

COMMENT #4			
Type of comment (check one)	***Non-Concur***	***Substantive*** ***X***	***Editorial***
Affected paragraph and page number	Page: 33 Paragraph: *IM3 NVTOL-TILT.1405 (b)(2)*		
What is your concern and what do you want changed in this paragraph?	**THE PROPOSED TEXT STATES:** at least six valid overflight test runs are needed **REQUESTED CHANGE:** at least six valid overflight test runs**, consisting of at least three with each head- and tail-wind, respectively,** are needed		
Why is your suggested change justified?	**JUSTIFICATION:** The intention of the six valid overflight test runs stated in this section could be interpreted as a requirement for the total of the head- and tail-wind runs, or a minimum number of pairs. Boeing recommends that EASA clarify this matter in the text.		

response

Not accepted.
Thank you for your comment, but the EPTS already contain the statement "with equal numbers with headwind and tailwind" right after the sentence that you quoted. Therefore, we consider that the current text does not need additional clarification.

IM4 NVTOL-TILT.1405 - Flight test procedures p. 33

comment *48* comment by: *Nico/Anotec*

b(3) How is the measured flight path descent angle defined? Average over the 10dB down interval? Should not be a point-to-point angle, which could show scatter. Or should the flight path points remain within the 5.5-6.5º wedge? Please clarify

response

Accepted.
Thank you for your comment. EASA will clarify the text in this Interpretative Material section by adding "averaged over the measured 10 dB-down period". The clarification will also be added to subparagraph (e)(4) of NVTOL-TILT.1405.

MoC1 NVTOL-TILT.1415 - Spatial positioning and speed measurement p. 37

comment	*49* comment by: *Nico/Anotec* The title of MoC1 includes "speed measurement" but the whole section doesn't refer to speed in any case. What are acceptable means to obtain TAS from ground speed?
response	Noted. Thank you for your comment. The title of MoC1 will be changed to "Spatial positioning methods" (without the mention of "speed measurement") in the final EPTS. Acceptable means to obtain TAS will be discussed on a project basis.

NVTOL-TILT.1505 - Microphone system characteristics and set-up p. 39

comment *44* comment by: *The Boeing Company*

COMMENT #5			
Type of comment (check one)	***Non-Concur***	***Substantive*** ***X***	***Editorial***
Affected paragraph and page number	Page: 39 Paragraph: *NVTOL-TILT.1505(a)(1)*		
What is your concern and what do you want changed in this paragraph?	**THE PROPOSED TEXT STATES:** Each microphone should be a 12.7 mm diameter pressure type, protected with a grid, mounted with the sensing element 1.2 m above the local ground surface and oriented for grazing incidence, i.e. with the sensing element substantially in the plane defined by the predicted reference flight path of the aircraft and the measuring station. **REQUESTED CHANGE:** Each microphone should be a 12.7 mm diameter pressure type, protected with a grid, mounted ~~with the sensing element 1.2 m above the local ground surface and oriented for grazing incidence, i.e. with the sensing element substantially in the plane defined by the predicted reference flight path of the aircraft and the measuring station~~ **in an inverted position such that the microphone diaphragm is 7 mm above and parallel to a circular metal plate. This white-painted metal plate shall be 40 cm in diameter and at least 2.5 mm thick, and shall be placed horizontally and flush with the surrounding ground surface with no cavities below the plate. The microphone shall be located three-quarters of the distance from the center to the edge along a radius normal to the line of flight of the test aircraft.**		
Why is your suggested change justified?	**JUSTIFICATION:** The use of 1.2 m pole-mounted microphones to measure the noise is not deemed appropriate for eVTOL vehicles. Instead, ground plane microphones should be used for both certification and data-gathering measurements. Ground plane microphones greatly reduce scattering effects caused by sound waves reflecting off of the ground, much increasing the quality and repeatability of certification measurements. Especially with a large number of distributed rotors, in the case of tilting rotors at a variety of incidence angles, and correspondingly complex tonal noise, avoiding ground bounce effects will be critical for maintaining data quality. Each testing facility has different natural ground characteristics that impact the sound measured by 1.2 m pole mounted microphones. In order to		

	accurately describe this effect, several measurements are taken to establish the ground impedance characteristics. The addition of the ground characterization effort adds complexity to an otherwise simple noise test. As potentially multiple eVTOL applicants will be using the proposed (or similar) rules, it is pertinent to establish a measurement system that provides consistent measurements without having to conduct large surveys and ground impedance characterization studies. By removing the ground characteristics from ground plane measurements, the data becomes more repeatable between tests. Already existing guidance in ICAO ETM Chapter 5, GM A6 4.4.1 clearly states the importance of using ground plane microphones, and can serve as a starting point for a ground plane measurement system in this EPTS. For example, the round ground plates used in ICAO Annex 16, Vol. 1, Chapter 10 certification greatly simplifies installation, and ground preparation for the noise test campaign. No aircraft have been certified to ICAO Annex 16, Vol. 1, Chapter 13 as of the date of this EPTS. As such, switching to a ground-plane microphone would improve the feasibility and consistency of measurements compared to ICAO Annex 16, Vol. 1, Chapter 13.

response

Not accepted.
Thank you for your comment, suggestions, and elaborated justification. While we recognize the merit of the expressed arguments, we will maintain the test setup to ensure commonality and level-playing field with the EPTS for VCA with non-tilting rotors, especially considering that both EPTS specify the same noise limits.

MoC3 NVTOL-TILT.1510 - Recording and reproducing system p. 44

comment

29 comment by: *Craig Mead*

MoC3 NVTOL-TILT.1510 states:

*'With respect to the specification of paragraph "(f)" of "NVTOL-TILT.1510 - Recording and reproducing system", a measurement system **should not have** level range controls that permit attenuation changes of, for example, either 10 dB or 1 dB. With 10 dB steps, the minimum overlap requested would be 40 dB ....'*

This does not seem to make sense technically. In contrast the equivalent paragraph in ICAO Annex 16 Vol. 1 App. 2 states:

*'It **is possible for** a measurement system to have level range controls that permit attenuation changes of, for example, either 10 dB or 1 dB. With 10 dB steps, the minimum overlap required would be 40 dB …'*

We believe that the paragraph as it currently appears in the EPTS is erroneous.

response

Accepted.
Thank you for your comment. The legacy text from Annex 16 Volume I ("it is possible") will be used in the final EPTS.

MoC1 NVTOL-TILT.1600 - Adjustments of the measured sound levels p. 52

comment	*50* comment by: *Nico/Anotec* In the first paragraph it says "...background noise present during the test **can** be subtracted ....". Does this mean that the measured spectra may be used without bgn correction?
response	Noted. Thank you for your question. It is indeed possible for an applicant NOT to subtract the background noise from the measured spectra. A background noise subtraction procedure is therefore not mandatory.

NVTOL-TILT.1700 - Noise data p. 69

comment	*9* comment by: *UK CAA* **Page No:** 69 **Paragraph No:** NVTOL-TIL.1700 Noise data **Comment:** SEL values for the overflight procedure, adjusted using the procedures prescribed in Appendix 4 of the Annex, should be reported in addition to the EPNL values. **Justification:** To enable comparison with the Chapter 11 limits and feed into possible future standard development.
response	Accepted. Thank you for your comment. The reporting of SEL values for each individual run will be added to NVTOL-TILT.1710 ("Additional test information") if the applicant is able to produce them.

2. Appendix A
Attachments

Attachment to comment in the second EASA EPTS .pdf
Attachment #1 to comment #1

W-ESMC-REG-24-VW-06 - EASA Consultation Paper - Environmental Protection Technical Specifications (EPTS) applicable to VTOL-capable aircraft powered by tilting rotors.pdf
Attachment #2 to comment #39

Attachment to comment in the second EASA EPTS .pdf

Attachment #3 to comment #2