

NASA_FRDOC_0001-0545 60-Day Notice Comment Responses

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Response to NASA_FRDOC_0001-DRAFT-0100

We thank the reviewer for their comments and the opportunity to respond. Our response is organized according to the main ideas conveyed in the comments.

Main Idea 1 – The test is unnecessary.

The relevant sentence of the comment reads: *“The proposed survey of AAM Noise Human Response is unnecessary, redundant, poorly designed, and wasteful of resources.”*

Response: For multiple reasons, the VANGARD test is, in fact, necessary, unique in its goals and application, and carefully designed to meet realistic goals. Most importantly, there has never been a psychoacoustic study directly applicable to an upcoming new generation of electric vertical take-off and landing air vehicles (eVTOLs) that will function as commuter transport between and within urban and suburban locations. The acoustic signature of such vehicles proposed in the VANGARD test is significantly different than those of traditional aircraft (jet aircraft, helicopters, and propeller aircraft)

considered in other studies. This is, in part, due to the use of electric motors in place of turbines and pistons, the use of multiple (>2) propellers/rotors, the variety of configurations (see <https://www.evtol.news/aircraft>), and the manner in which they operate.

We respectfully disagree that the VANGARD test is a waste of resources. The test considers human response based on the differing acoustical characteristics of eVTOLs from a variety of manufacturers, and the resulting data will be examined in terms of objective acoustic and psychoacoustic sound quality metrics in addition to subjective annoyance response. This is of critical importance for eVTOL manufacturers to understand how their novel aircraft acoustic signatures will impact listeners and provide the information needed to improve future designs. As such, it functions as a worthwhile investment of resources by NASA.

Main Idea 2 – Data from the test will be used for regulatory purposes.

The relevant sentence of the comment reads: *“The existing body of noise tolerance studies, which surveyed much larger cohorts in real world conditions, are more than sufficient for FAA to set AAM noise regulations.”*

Response: The VANGARD test is not designed for the FAA to set AAM/UAM noise regulations, nor is it designed to set noise tolerances. The VANGARD test is a laboratory psychoacoustic test that will be administered remotely. It is not a replacement for community noise testing in real word conditions. As indicated in the Federal Register Notice, the primary research objective of the VANGARD test is to determine if there are statistically significant differences in annoyance between subjects who live in low versus high ambient noise environments.

Main Idea 3 – Relationship to other studies.

The relevant sentences of the comment read: *“Those studies include the ones done by the Volpe Center by Amada Rapoza, which looked at noise tolerance in the quiet ambience of National Parks. Other studies looked at the noise tolerance of frequent night flights. The FAA’s new noise tolerance study known as ‘The National Curve’ is current and used 10,000 subjects.”* and *“Ignoring prior studies is likely to result in setting allowable noise levels too high, which would perpetuate decades of community complaint about aviation noise.”*

Response: This work builds on the knowledge of human response to aircraft noise obtained through prior studies. We are aware of the prior studies, including those cited, and do not see a logical connection between the present study and possible changes in “allowable” noise levels. As stated above, the VANGARD test is not intended to support future regulation.

It is important to point out differences between the studies cited and the VANGARD test. The context of the Rapoza study was aircraft noise in National Parks having low ambient levels. The impact of aircraft noise on park visitors is quite different from considerations in urban-suburban commuting contexts, where ambient levels and characteristics are significantly different. The noise tolerance of frequent night flights is not within the scope of the VANGARD study.

The “National Curve” in the above comments refers to a long-term dose-response relationship between day-night average sound level (DNL) and annoyance. This relationship was established in the FAA Neighborhood Environmental Survey (NES)

(https://www.faa.gov/regulations_policies/policy_guidance/noise/survey) based on annoyance ratings to traditional aircraft for communities located in the *near vicinity of existing airports*, that is, in environments in which the aircraft noise is dominant. In contrast, the VANGARD test examines the short-term annoyance response in both low and high ambient noise environments.

Main Idea 4 – Laboratory vs real world studies.

The relevant sentences of the comment read: *“Noise tolerance must be [sic] studies in a real world setting. Electronic simulations of noise do not capture the experience and are subject to error.”*

Response: The commentor is correct in that noise tolerance, which we interpret to mean a long-term dose response relationship, must be studied in a real-world setting, that is, a setting in which real aircraft are flying real operations over real communities. This is what the FAA NES set out to evaluate (see above). It is not possible, nor is it the goal, to relate the short-term AAM/UAM annoyance response obtained in the VANGARD study to a long-term response as would necessarily have to be measured in an NES-like study.

We respectfully disagree that “electronic simulations of noise do not capture the experience” since well-established, peer-reviewed research using electronic simulations of noise has informed psychoacoustics in general and aviation annoyance response studies in particular for decades; all studies of course are subject to quantifiable “error,” which is reported as part of a scientific study.

Main Idea 5 – Choice of best metric.

The relevant sentences of the comment read: *“Time and again, noise studies have shown the validity of using the dBA scale as the best metric for noise measurement. All studies must include the sideline distance to the observer else the dBA levels are meaningless.”*

Response: We respectfully disagree with the statement that the “dBA scale as the best metric for noise measurement.” While we agree that use of A-weighted decibels is useful in many contexts, this statement is an oversimplification of traditionally-used metrics in aviation noise including those that account for the duration of single and multiple events, that is, the sound exposure level (SEL) and DNL. Further, simple measures like A-weighted decibels may not adequately reflect other attributes of AAM/UAM noise, e.g., amplitude modulations that may arise when multiple rotors operate at close, but not identical, rotational frequencies. For this reason, we will include A-weighted decibels in our analyses, along with other metrics that reflect a more contemporary understanding of human response to noise and that are reported in other recent studies.

With respect to sideline distance, sounds in the VANGARD study are chosen to represent a range of sideline distances. This is achieved by scaling the sound stimuli according to the physics of atmospheric sound propagation.

[Response to NASA_FRDOC_0001-DRAFT-0102](#)

The following summary addresses various statements made in this comment:

At present, there is no known human noise response testing that has been conducted on a variety of cargo and passenger carrying Advanced Air Mobility (AAM)/Urban Air Mobility (UAM) aircraft in different flight conditions from respondents in different geographic locations. The VANGARD laboratory test seeks to gather responses to address this insufficient data. VANGARD research objectives, given in

the information collection statement, seek to answer foundational questions that can help design future studies on AAM/UAM noise response. The information in the VANGARD can provide additional data to update preliminary annoyance response models that may play an increasing role in the design of aircraft components. The VANGARD test objectives are not designed to affect existing or proposed aviation operations and noise policies. The VANGARD test is not a replacement for community noise testing in real word conditions. However, data on the short-term annoyance to AAM/UAM aircraft can inform decisions on determining long-term annoyance to AAM/UAM aircraft. These decisions include, but are not limited to, which classes of AAM/UAM aircraft to consider, which flight operations require additional human noise response investigations, and where to conduct long-term annoyance studies.

It is challenging for a single laboratory test to cover every aspect of how people will experience the noise from AAM/UAM aircraft. Multiple laboratory tests are needed with each covering a different aspect of AAM/UAM aircraft noise response. Laboratory tests need to be completed in relatively short amounts of time, and the time limitation is stricter for online testing where respondents are more likely to leave tests incomplete if the tests are relatively long. The main portion of the VANGARD test is expected to take approximately 30 minutes to complete. This time limit can address the VANGARD research objectives with the expected durations of test stimuli, but it will be challenging to address other research questions that comment NASA_FRDOC_0001-DRAFT-0102 mentions. The effects that multiple AAM/UAM flights may have on noise annoyance was investigated in the reference given in Statement A2 of the information collection, but additional laboratory studies on the effects of multiple AAM/UAM flights on noise annoyance are being planned by NASA. Such studies may incorporate the effects of multiple airports/helipads/vertiports. The N-Above or N-Above-Ambient may be metrics to consider in these tests, as comment NASA_FRDOC_0001-DRAFT-0102 suggests. Connecting the single event response to multi-event response is also a focus of future work to expand the psychoacoustics annoyance model to account for these effects.

Additional online testing that focuses on respondents with various levels of aircraft noise events, as comment NASA_FRDOC_0001-DRAFT-0102 suggests with Groups A-G, may be important to perform in the future. Response to nighttime flight may also be considered if nighttime AAM/UAM operations are a possibility. VANGARD test administrators decided to focus on entire metropolitan areas and not just areas in the vicinity of airports because AAM/UAM aircraft operations are expected to cover a larger portion of a metropolitan area despite initial AAM/UAM flights being likely to have at least one destination be an airport. Challenges in respondent recruitment from specific areas with certain aviation noise event frequencies was another reason to focus on the larger metropolitan areas. If there are sufficient respondents from the VANGARD test that can be divided into aircraft noise event groups A-G like comment NASA_FRDOC_0001-DRAFT-0102 suggests, then VANGARD test results may be reanalyzed with groups A-G without having to conduct a new online test.

Statement B1 of the information collection details how “high” and “low” ambient noise will be defined. The definitions are based on L50 values obtained from the National Park Service. The definitions of “high” and “low” ambient noise guide respondent recruitment, but analyses of test results may use different definitions of “high” and “low” ambient noise as mentioned in the information collection statement.

To address the “Disclosure and Scientific/Ethical Integrity” portion of comment NASA_FRDOC_0001-DRAFT-0102, the investigators mostly agree with the comment but with following clarifications:

- NASA conducts an internal review of proposed tests with a panel of technical experts to ensure technical excellence and fulfills requirements established in the NASA Langley Research Center document: “Conducting Research Activities in the Research Directorate” (LM-OP-7831).
- Publications by NASA-authors are subjected to peer-review under the “Scientific and Technical Information (STI) Technical Review” (NF1915) prior to submission to external journals/conferences. These reviewers are typically noted in the “Acknowledgments” section of NASA-produced publications.
- Publications submitted to journals will be subject to the established peer-review process, which typically involves a well-established blind review.
- Test responses to all stimuli, including ZIP codes of respondents, will be made available. Sound stimuli will not be made available because keeping the sound stimuli unreleased was a condition in official agreements under which sounds were acquired from AAM/UAM manufacturers.
- AAM/UAM sound stimuli will be described to the extent that their sound pressure time history is not revealed and that the AAM/UAM manufacturers of the sound stimuli are not revealed. Other aspects of the AAM/UAM sounds that do not reveal their sound pressure time history will be described.

To address the “What to Avoid” portion of comment NASA_FRDOC_0001-DRAFT-0102, the investigators mostly agree with the comment but with following clarifications:

- For the VANGARD test, an effort has been made to acquire as many varied AAM/UAM stimuli as possible while working within resource limitations and the ability of AAM/UAM manufacturers to provide sounds.
- Respondents will be recruited from areas that are likely to see initial AAM/UAM operations. The way ambient locations are categorized as “high” or “low” is detailed in the information collection statement.
- As described in the information collection statement, after the VANGARD test provides human noise response data to cargo and passenger carrying AAM/UAM vehicles, subsequent tests can be better designed to understand the effects of different number of flights and frequency of flights. NASA has performed a test on the number of flights, which is referenced in the information collection statement, but additional tests regarding human noise response effects to the number of flights are being planned. VANGARD test results can help define which stimuli to use in these upcoming tests. Information on the human noise response to single event AAM/UAM aircraft flights can help reduce the ambiguity in results on how annoyance changes with the number of flights, define which aircraft sounds to use in a test regarding the number of flights, and help connect the single event response to multi-event response.
- While the VANGARD test would ideally use recordings of AAM/UAM aircraft for all its stimuli, it is still challenging to acquire recordings of all AAM/UAM aircraft. Therefore, the VANGARD test will use both recordings and simulated sounds of aircraft. The simulated sounds are referred to as auralizations. This information collection statement provides references to research NASA has done to increase the realism of rotorcraft auralizations, which include AAM/UAM vehicles in various flight conditions. Noise emitted from multiple rotors are used in the auralizations. Propagation effects including atmospheric attenuation and ground reflections are present in the auralizations. NASA continues to conduct research to improve sound simulation and auralization capabilities.

- While conventional metrics like A-Weighted Sound Exposure Level will be analyzed for their ability to describe annoyance responses, other metrics, like sound quality metrics, will also be investigated for their ability to describe responses. Stimuli flight parameters will also be investigated for their relationship to annoyance if they do not reveal the AAM/UAM manufacturers of the stimuli.
- Regarding additional community feedback, VANGARD test progress, VANGARD test results, and future test plans will have public dissemination, discussion, and feedback at public conferences/meetings and publicly available publications. The Aviation Noise Emissions Symposium is one such forum. For one to obtain feedback from select community members, one needs to know which communities may be affected, but VANGARD test objectives are not designed to affect existing or proposed aviation operations and noise policies in any community.

In response to the section of comment NASA_FRDOC_0001-DRAFT-0102 that discusses testing flight phases, the following are clarifications:

- Comparisons of noise response for takeoff and landing phases of flight will only be done between the same aircraft as described in the information collection statement. A comparison may also be done between the responses to all takeoff stimuli and the responses to all landing stimuli. Aircraft descriptions and sound characteristics will be described to the extent that they do not reveal the AAM/UAM manufacturers of the aircraft. Including responses to hover portions of flight will make the VANGARD test longer than necessary to accomplish research objectives. One reason is that most available hover sounds exist separately from takeoff and landing sounds and will need to be played as separate stimuli. Response to hover portions of flight may be explored in subsequent investigations. Information from AAM/UAM operators on the expected durations of hover conditions, which are currently not known to VANGARD test administrators, will be helpful for these subsequent investigations.

In response to the section of comment NASA_FRDOC_0001-DRAFT-0102 that discusses testing annoyance as a function of distance from aircraft, the following are clarifications:

- VANGARD test objectives are not designed to affect existing or proposed aviation operations. Planned AAM and VFR corridors have not been communicated to VANGARD test administrators, and accurately determining the anticipated noise levels in planned AAM and VFR corridors is out of scope of the test. The VANGARD test is one of many laboratory tests that will investigate human noise response to AAM/UAM noise. The VANGARD test will not be the only opportunity to assess human noise response to AAM/UAM operations.

In response to the section of comment NASA_FRDOC_0001-DRAFT-0102 that discusses objective parameters to describe the annoyance response, the following are clarification to each objective parameter:

- Ambient Noise: The effects of ambient noise on AAM/UAM noise response are planned to be further tested in upcoming laboratory tests. The information collection statement references an initial test on the effects of ambient noise that AAM/UAM noise response that has already been conducted by NASA.

- Count of Events, Cadence: See second paragraph of the response to comment NASA_FRDOC_0001-DRAFT-0102 and third bullet of the response to the “What to Avoid” section of the NASA_FRDOC_0001-DRAFT-0102 comment.
- Time of occurrence: The VANGARD test will have respondents react to the sound stimuli in the context of daytime. A longer test will likely need to be designed if responses to different times of day are tested, which increases the likelihood of incomplete tests. Subsequent testing can investigate variation in AAM/UAM noise response to different times of day.
- Metrics, No averages: See next to last bullet of the response to the “What to Avoid” section of the NASA_FRDOC_0001-DRAFT-0102 comment. Metrics will be calculated for single event aircraft flights and will not be cumulative over multiple flights. Some metrics that will be investigated for their ability to describe the annoyance response may be of average sound characteristics over the entire aircraft flight, such as average loudness. Other metrics that will be considered, like peak levels, will not compute average values.
- Estimation errors: Error bars, distributions, and confidence intervals of various parameters, including annoyance and noise levels, will be reported in test results to help explain findings.
- Low altitudes: The attempt is being made that VANGARD test cargo and passenger carrying AAM/UAM noise stimuli will be flown at altitudes that are representative of their flight conditions. The VANGARD test will not have stimuli of unmanned aircraft that do not carry passengers or equivalent cargo.
- AAM/UAM fleet mix versus a single aircraft, Phase of flight variations: For the VANGARD test, an effort has been made to acquire as many varied AAM/UAM stimuli as possible while working within resource limitations and the ability of AAM/UAM manufacturers to provide sounds.
- AAM/UAM and traditional motor noise: An attempt has been made to acquire AAM/UAM sound stimuli that represent initial eVTOL aircraft that will fly over communities.
- Existing or non-existing aviation noise: See third paragraph of the response to comment NASA_FRDOC_0001-DRAFT-0102.

[Response to NASA_FRDOC_0001-DRAFT-0106](#)

Analyses of NASA_FRDOC_0001-0545 data will see if parameters other than just the metrics used for noise certification or noise policy better describe the reaction to the AAM noise stimuli. Examples of these metrics include, but are not limited to, sound quality metrics (e.g., roughness, loudness), psychoacoustic annoyance, and attributes of the sound spectra.

[Response to NASA_FRDOC_0001-DRAFT-0127, -0174, -0195, -0207, -0212, -0238, -0251, -0262, -0273, -0329, -0344, -0350, -0352, -0391, -0411, -0413, -0415](#)

The study in NASA_FRDOC_0001-0545 seeks to gather data that will contribute to an improved understanding of Advanced Air Mobility (AAM) aircraft noise human response. The study is not targeted at influencing planned aircraft operations and is not targeted at influencing aircraft noise policy.

Additional information may be found in the response to NASA_FRDOC_0001-DRAFT-0102.

[Response to NASA_FRDOC_0001-DRAFT-0201, -402](#)

The psychoacoustic test that is proposed in NASA_FRDOC_0001-0545 does not address the noise of air taxis relative to other transportation noise sources, including road traffic (-201) and commercial transports (-402). One investigation comparing annoyance between small drones (package delivery size)

and automobiles was conducted by Christian and Cabell [ref: <https://ntrs.nasa.gov/citations/20170005870>]. Separately, the FAA Noise Policy Review, <https://www.faa.gov/noisepolicyreview>, is part of efforts by the FAA to address limitations in current modeling.

[Response to NASA_FRDOC_0001-DRAFT-0204](#)

Regarding air pollution in the form of soot and its effect on health, AAM aircraft are expected to use electric propulsion, and therefore, NASA_FRDOC_0001-0545 does not address air pollution nor any possible health impacts due to air pollution. The effect of aircraft noise on learning has been studied elsewhere (for example, see <https://fican1.wordpress.com/findings/>) and is not within the scope of this study. Regarding propagation of noise in urban environments (e.g., freeway corridors and ‘urban canyons’), noise travels differently in these environments than it does in open, unobstructed space. The study in NASA_FRDOC_0001-0545 does not address how the aircraft noise reaches people in different locations. It does, however, addresses how people respond to noise once it reaches them.

[Response to NASA_FRDOC_0001-DRAFT-0221, -0323](#)

Per NASA_FRDOC_0001-0545, the National Aeronautics and Space Administration (NASA) is committed to effectively performing the Agency’s communication function in accordance with the Space Act Section 203 (a)(3) to “provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof,” and to enhance public understanding of, and participation in, the nation’s aeronautical and space program in accordance with the NASA Strategic Plan.

[Response to NASA_FRDOC_0001-DRAFT-0233, -0234, -0244, -0268, -0283, -0285, -0288, -0290, -0310, -0316, -0317, -0335, -0353, -0367, -0369, -0370, -0371, -0373, -0378, -0406, -0107, -0108, -0110, -0112, -0120, -0129, -0135, -0171, -0180, -0224, -0225, -0414, -0427, -0437](#)

The study in NASA_FRDOC_0001-0545 seeks to gather data that will contribute to an improved understanding of Advanced Air Mobility (AAM) aircraft noise human response. Additional test details are provided in the Paperwork Reduction Act submission. Data from NASA_FRDOC_0001-0545 will be publicly available. With this improved understanding, additional steps may be planned by government, industry, and communities on how to reduce the aviation noise burden on communities. These steps include, but are not limited to:

- Additional controlled laboratory psychoacoustic testing that addresses technical gaps in AAM human noise response that are uncovered or unaddressed by the results in NASA_FRDOC_0001-0545. For example, an initial understanding of how AAM noise is perceived from NASA_FRDOC_0001-0545 can inform the design of a subsequent psychoacoustic tests on how AAM vehicle sounds that are mixed with various background sounds will be perceived and how the frequency of AAM flights will be perceived. The study in NASA_FRDOC_0001-0545 will not visually show aircraft, but its results can inform subsequent testing that investigates how human noise response changes when the aircraft are visually shown. The study in NASA_FRDOC_0001-0545 is expected to be one of many studies on AAM noise human response to be conducted.

- Provide data for prediction models that incorporate human response as part of the objective functions in the AAM aircraft design cycle to produce aircraft with sound characteristics that are less annoying to individuals.
- Provide evidence-based data on where community noise field tests with real AAM aircraft should or should not direct their efforts to validate aircraft operations that minimize the noise burden on communities.

The following list are items that the study in NASA_FRDOC_0001-0545 will not do and will not cover:

- The study in NASA_FRDOC_0001-0545 will not fly real Advanced Air Mobility (AAM) aircraft over communities.
- The study in NASA_FRDOC_0001-0545 is not targeted at influencing planned aircraft operations, which involve privacy concerns, and is not targeted at influencing aircraft noise policy.
- AAM aircraft are expected to use electric propulsion, and therefore, NASA_FRDOC_0001-0545 does not address air pollution.
- While air safety is an important part of AAM research, NASA_FRDOC_0001-0545 is focused on the noise aspect of AAM research. Addressing air safety will be outside the scope of NASA_FRDOC_0001-0545.
- Test administrators for NASA_FRDOC_0001-0545 do not have the resources to investigate aviation noise effects on wildlife. Therefore, NASA_FRDOC_0001-0545 will not address how AAM noise affects wildlife.
- NASA_FRDOC_0001-0545 will not investigate conventional jet aircraft noise human response.
- It is not yet clear if and how much AAM vehicles will operate at night, and therefore, NASA_FRDOC_0001-0545 will not ask test participants to focus on responding to nighttime operations.

Response to NASA_FRDOC_0001-DRAFT-0239

The researchers for this study agree that other urban areas other than Los Angeles, Dallas, and New York City, including those of Virginia, Maryland, and DC near Reagan Airport (DCA), have “high ambient noise” environments and are areas that will likely be early adopters of AAM/UAM aircraft. With limited resources available to the researchers for test subject recruitment, the recruitment will focus on the three areas of Los Angeles, Dallas/Fort Worth, and New York City. The information collection statement gives more details on how these three metropolitan areas were selected.

Response to NASA_FRDOC_0001-DRAFT-0256, -0293, -0402

A laboratory type study, like that proposed in NASA_FRDOC_0001-0545, is not intended to, nor is capable of, reflecting real-world conditions experienced by real communities exposed to the noise of real AAM aircraft operations. For that, a study like the FAA Neighborhood Environmental Survey (https://www.faa.gov/regulations_policies/policy_guidance/noise/survey) is needed. However, that is not possible until (and if) air taxi operations commence in real-world conditions. The knowledge gained from the study in NASA_FRDOC_0001-0545, however, will help inform such noise surveys if and when they may occur in the future. Only then may the data gathered through such real-world surveys be used to support development of future noise policies.

A comment by -0402 also addressed the variability of personal audio equipment. A NASA study that preceded the one proposed in NASA_FRDOC_0001-0545 (see

<https://ntrs.nasa.gov/citations/20230002028>) verified that the remote test system being proposed for the current study using personal audio equipment could replicate findings obtained in a dedicated psychoacoustic laboratory test environment.

Response to NASA_FRDOC_0001-DRAFT-0261, -0281

Comments NASA_FRDOC_0001-DRAFT-0261, -0281, appear to introduce the commenters. Test administrators do not understand how to respond to these comments, and, therefore, responses are not being given to these comments.

Response to NASA_FRDOC_0001-DRAFT-0267

The psychoacoustic test that is proposed in NASA_FRDOC_0001-0545, is not designed to address consumer complaints and is not designed to address health detriments because addressing these areas are outside the capabilities of the test administrators. The test will use annoyance to assess noise response and gather data on Advanced Air Mobility noise according to ISO (the International Organization for Standardization) Technical Specification (TS) 15666. There have been investigations linking annoyance to the health outcomes. One such investigation is Babisch, W. "The noise/stress concept, risk assessment and research needs." Noise Health 4, 1 (2002), but other references linking annoyance to health outcomes may be found.

Response to NASA_FRDOC_0001-DRAFT-0387

Separate responses are provided to each issue that this comment raises.

- Annoyance is the first line response to noise, consider other health implications (sleep disruption, interference with activities, emotional responses, leading to cardiovascular disease and metabolic disorders).
 - Response: Considering health implications will require resources that are not currently available to the test administrators. A potential response to considering other health implications will be outside of the scope of this study.
- Mentions repetitive noise, tonality, sharpness, roughness, high frequency broadband noise. -> Annoyance model containing these as factors
 - Response: Characteristics of the noise sources including, but not limited to, sound quality metrics and broadband noise levels are expected to be analyses parameters to understand which parameters are the most important to describing the annoyance response to the test stimuli.
- Nighttime noise disturbances more harmful
 - Response: Covering the effects of nighttime Advanced Air Mobility (AAM) noise will require the study to become larger, which increases the chances that respondents will leave the test incomplete. At this time, more clarity is needed on how much AAM vehicles will operate during nighttime. AAM nighttime operations may become critical gap to address in the future, and subsequent tests will be needed.
- Building construction should be considered
 - Response: The perception of Advanced Air Mobility (AAM) noise indoors is an important facet of AAM noise to understand. The VANGARD test will not use sounds that transmit indoors. The test will seek to understand what noise characteristics contribute most to AAM noise annoyance. One may model AAM noise propagation indoors using various

building construction models. With these models and results from the VANGARD test, predictions may be made on how building construction may affect AAM noise annoyance. It is still likely, however, that a separate test focusing on indoor noise annoyance may be needed.

- Health experts should be involved. E.g. physiology, clinical medicine, public health. Close gap between health science and FAA's noise policies
 - Response: Considering health implications will require resources that are not currently available to the test administrators. A potential response to considering other health implications will be outside of the scope of this study.
 - The AAM/UAM aircraft that will be tested in NASA_FRDOC_0001-0545 will be that of cargo or passenger-carrying aircraft. Understanding the response to noise from small unmanned aircraft, or drones, is out of scope for this study.

[Response to NASA_FRDOC_0001-DRAFT-0433](#)

Regarding the short-term vs long-term (cumulative) exposure, the commentor is directed to the response to NASA_FRDOC_0001-DRAFT-0256, -0293, and -0402. A laboratory study of this type can only address short-term exposure, even if that is to several events. The response to long-term exposure can only be ascertained in a community test like the FAA Neighborhood Environmental Survey.

Regarding the frequency content of the aircraft noise, acoustic signals used in the test will be from a combination of recordings of prototype vehicles and simulated sounds for a range of prevalent air taxi vehicle architectures.

This is a NASA study (not an FAA study) that will incorporate the appropriate frequency content of the aircraft noise, but that will not address the response to long-term exposure. Additional studies will be required to address the latter.

[Response to NASA_FRDOC_0001-DRAFT-0438](#)

Separate responses are provided to each issue that this comment raises.

- Extending hearing range
 - Response: It is correct that the proposed study will not adequately assess the response to the low frequency content of sounds because headphones/computer speakers will be used. Follow-on testing with the same or similar sound stimuli is proposed in more controlled laboratory settings that can produce low-frequency content. However, the more controlled laboratory settings occur in larger in-person test facilities that require test subjects to travel to the testing facilities. Responses to the low-frequency content is challenging to be gathered from geographically distributed test subjects. Variation in responses from the online test where test subjects are not responding low frequency content may be compared and calibrated to results from follow-on testing with in-person test facilities where low frequency content is produced.⁴
- Testing with children
 - Response: Currently, the test administrators do not have the authorization to perform testing on people under the age of 18 and do not have the authorization to perform health assessments. Therefore, responses to the issue of analyzing responses from children and adults with low frequency hearing ability will be out of scope for this effort.

- Emphasis on inner-ear vestibular damage caused by low frequencies.
 - Response: Considering health implications will require resources that are not currently available to the test administrators. A potential response to considering other health implications will be outside of the scope of this study.
- UAM will be “impactful to people who moved away from urban centers seeking quiet”
 - Response: Analyses of test results will focus on response differences between “high ambient noise” and “low ambient noise” areas and not on responses from only within urban centers. The information collection statement provides additional details on how respondents within metropolitan areas are selected for the study.
- Wants studies to converge on repeatable results
 - Response: This testing effort is expected to be one of many other testing efforts on Advanced Air Mobility noise human noise response. Subsequent testing may repeat this study’s research objectives to verify conclusions with additional data.
- Claims speakers can’t accurately replicate the entirety of the sound profile. Recommends using actual noise sources (assuming the commenter is referring to recorded sounds) and comparing responses to subjects who listened on speakers.
 - Response: It is anticipated that speakers and headphones will not be able to replicate the entirety of sound profiles. Test results are expected to be compared/calibrated with follow-up additional testing with in-person test facilities that can reproduce more of the frequency content of sounds, including low frequency content. Due to challenges in acquiring Advanced Air Mobility (AAM) noise recordings, some stimuli will be simulated sounds. The information collection statement references research into generating simulated sounds of rotorcraft. This study will not be the only study on AAM noise response, and as more recorded sounds of AAM aircraft become available, the recordings can be used in subsequent tests.
- Claims metrics (dBA) that correlate with annoyance do not accurately assess annoyance.
 - Response: Annoyance responses to test stimuli will be compared with a variety of metrics to understand which metric best describe the annoyance response. The metrics include conventional ones like A-weighted sound exposure level but also perception metrics like loudness. Responses will also be analyzed against sound quality metrics that have not been standardized for certification like impulsiveness, roughness, and psychoacoustic annoyance.
- Suggests comparing natural sounds (waterfalls) to rotorcraft at equal dBA
 - Response: The objective of this test is not to obtain absolute annoyance ratings to Advanced Air Mobility (AAM) aircraft against responses to natural sounds. It is hypothesized that many natural sounds will be perceived as less annoying than AAM aircraft sounds for an equal A-weighted sound exposure level. If this hypothesis is correct, rating natural sounds along with AAM noise will skew AAM noise responses to be concentrated to higher annoyance ratings, and it will make it more difficult to discern how annoyance changes for AAM noise by itself. Subsequent testing may compare AAM noise human response with more familiar sounds, and the tests can be designed to have a good balance between AAM sounds and more familiar sounds.
- Include subjects sensitive to low-frequency noise and vibration (hyperacusis, autism, etc.), perhaps from previous noise damage.

- Response: Considering health implications will require resources that are not currently available to the test administrators. A potential response to considering other health implications will be outside of the scope of this study.
- Defining “Quiet areas”
 - Response: The study will ask test participants to respond to aircraft noise according to how they would feel if they heard the aircraft noise at home. A test hypothesis is that the ambient environment of test subject ZIP codes will affect the average or median annoyance response value to aircraft noise and other potential influential parameters, like work environment, do not considerably affect the average or median response. The “low ambient” and “high ambient” environments are determined from the L50 values of ZIP codes, with the L50 value being an A-weighted metric. If a difference in average or median annoyance response values between test subjects from “low ambient” and “high ambient” environments are not found, then it may mean that additional investigations will be needed to discern if other parameters like work environment are affecting results. A source of unweighted metrics for all United States ZIP codes could not be determined. If a source for unweighted metrics of ambient sounds become available, results may be reanalyzed by dividing up test subjects into “low ambient” and “high ambient” environments based on the unweighted metrics.