DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

Noise Certification Standards: Zipline International Model Zip

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final rule of particular applicability (RPA).

SUMMARY: The Federal Aviation Administration (FAA) is promulgating noise certification standards that would apply only to the Zipline International (Zipline) Model Zip (Zip) unmanned aircraft (UA) because no generally applicable noise certification standards were available for this aircraft at the time the aircraft was presented for certification. In order to complete the type certification process for noise for this aircraft, the FAA adopts the standards in this rule for the Zipline Zip.

DATES: This rule is effective July 3, 2023.

ADDRESSES: Send comments identified by the aircraft, Zipline Zip, using the following e-mail address: NoiseCertificationStandard@faa.gov.

FOR FURTHER INFORMATION CONTACT: Contact the Federal Aviation Administration, Office of Environment and Energy, Noise Division, 800 Independence Ave. SW, Room 900 West, Washington, D.C. 20591, or e-mail NoiseCertificationStandard@faa.gov.

SUPPLEMENTARY INFORMATION:

I. Authority for this Rulemaking

A. General

The FAA's authority to issue rules on aviation safety is found in Title 49 of the United States Code. Subtitle I, section 106 describes the authority of the FAA

Administrator. Subtitle VII, Aviation Programs, describes in more detail the scope of the agency's authority.

This rulemaking is promulgated under the authority described in subtitle VII, chapter 447, and section 44715. Section 44715(a)(3) states that an original type certificate for an aircraft may be issued only after the Administrator of the FAA prescribes noise standards and regulations under that section that apply to the aircraft. This regulation is within the scope of that authority.

II. Background

A. Need for this rulemaking

All aircraft must meet noise certification requirements to receive a type certificate in the United States. Section 44704 of Title 49 of the United States Code requires the FAA to issue a type certificate to an applicant that presents an aircraft, engine, propeller or appliance that is properly designed and manufactured, performs properly and meets the regulations and minimum prescribed standards. Section 44715(a)(3) requires the FAA to prescribe noise standards for an aircraft before a type certificate may be issued.

The current noise standards are contained in part 36 of Title 14 of the Code of Federal Regulations. Within part 36, aircraft are distinguished by type, including jet airplanes, large turboprop airplanes, small airplanes, helicopters, and tiltrotors. When the FAA began issuing type certificates for unmanned aircraft (UA) several years ago, it used the noise standards for the type of manned aircraft that was most like the UA seeking type certification, and that was compatible with the type classification. In the first two certifications, the FAA applied the small airplane standards under subpart F and appendix G to part 36. Similarly, the small helicopter standards of part 36 subpart H and appendix

J might also be found to be applicable based on the design of an aircraft presented for certification.

The increasing complexity of low-altitude UA operations has caused the FAA to re-evaluate whether the requirements for certain categories of aircraft (e.g., helicopters, tiltrotors, small propeller-driven fixed wing airplanes) described in part 36 are appropriate for the noise certification of particular UA designs such as the Zipline Zip aircraft addressed in this rulemaking. The FAA has begun to evaluate the level of noise generated by these aircraft. In many cases, UA are small, electrically (battery) powered, and may include distributed propulsion systems. As a result, these aircraft may generate less noise than was contemplated when part 36 was promulgated.

Another significant consideration is the expected operating environment for UA. Manned airplanes and helicopters normally operate from airports or helipads that include property that serves as a primary buffer from the general population. The established methods of measuring and determining proper noise limits in part 36 use these proximities to the population as their bases, with measurements taken at test locations and at altitudes representative of takeoff and landing. However, the UA addressed in this rule is intended to operate in closer proximity to people, such as delivering packages in residential areas. These uses are expected to have an impact on persons and property at closer distances than traditional manned aircraft. Traditional test methods would not accurately measure those noise impacts.

When tested at the current reference altitudes of part 36 for manned aircraft, the noise generated by many UA could be lost in the ambient background noise, while the noise in their proposed operating environments would be more apparent to persons near it.

The use of distributed electric propulsion and a high level of automated control at each rotor allow multirotor UA to operate with a variety of profiles. The complex vortex field created by the interaction of the rotors, combined with the airframe, can cause such aircraft to exhibit tonal and broadband spectral content and unique noise directivity patterns that are often coupled with the vehicle flight dynamics and flight profiles. Such noise characteristics and flight profiles were not considered previously under the standards and testing contained in part 36 and its appendices for aircraft of traditional design. These new noise characteristics and flight profiles are examples of the factors that lead to the FAA's testing of these aircraft to gather consistent data as a means to understand their relevance and eventual use in informing future standards generally applicable to UA.

Effective noise regulations require a base of data gathered from a test environment common for all aircraft, and certifications of UA such as this one, represent the early stages of larger data gathering. At present, the FAA does not have a sufficient database of information about the noise generated by most UA models because of their novelty and variety. While small UA have operated under part 107 for several years, those aircraft do not have type or airworthiness certificates and did not require noise testing. Thus far, the FAA and industry have collected only limited noise data on those smaller models and most of the collected data was acquired in a manner inconsistent with formal noise certification test conditions, making it unreliable for inclusion into any database that would support future general noise certification standards for UA.

As industry seeks both type and airworthiness certification for UA to allow operation under part 91 or commercial operation under part 135, the FAA and industry are working toward a noise certification paradigm that can accommodate new operational

concepts that will be addressed in part 36 regulations of general applicability. The general standards will be built from a database of noise characteristics gathered as part of individual UA noise certification projects. Such data gathering takes time and requires input spanning a number of models and designs before the influences of design on noise can be fully understood. The FAA may use data collected through this rule to inform future standards.

B. Availability of noise RPAs

The FAA continues to evaluate the components of a noise certification basis that are appropriate for individual UA projects as certification applications are received. Many of these noise certification projects have already been recognized for their similarities in design and concept of operation. When a UA is presented for certification, the FAA considers the following in developing a noise certification basis:

1. Current part 36 noise limits (extrapolated for weight and adjusted for the reference altitude) to maintain a level playing field with traditional aircraft – UA will not be allowed to exceed established regulatory limits;
2. Current procedures in part 36 to assess UA flight configurations and capabilities when they can be applied fairly to a new certification;
3. Similarity in aircraft design and operation to UA that have been certificated for noise previously;
4. Whether less complex testing procedures are appropriate;
5. Noise measurement methods relevant to the UA's intended application.

For example, although each UA has its own intended application, the FAA has found that the level flight segment is an appropriate common denominator when testing multicopter UA noise. A level flight segment is already in use in the certification of

lighter weight manned helicopters under part 36 appendix J. When evaluating fixed-wing aircraft, the FAA may use Appendix G, which focuses on characteristics other than level flight.

The FAA will be issuing rules of particular applicability in two forms. When presented with an unmanned aircraft for which there is no previously used and appropriate noise certification basis, the FAA will conduct full notice and comment rulemaking, including publication of the proposed noise standards in the Federal Register with the solicitation of public comment, and a disposition of comments in a final rule.

Alternatively, if a noise certification applicant presents a UA for certification and the FAA finds that the appropriate noise certification basis is essentially the same as the standard adopted previously for another UA, the FAA will adopt that same standard for the new applicant as a final rule of particular applicability without publication in the Federal Register for public comment. The FAA will contact the applicant to provide an opportunity for comment on the content of the rule before it is issued. The FAA will then serve the applicant individually with the complete final rule, and will include the rule in the agency's routine notices of availability published in the Federal Register. The FAA will maintain a database of all US RPAs on its website, available to the public. The FAA's database of all noise certification RPAs whether published for notice and comment as an NPRM or adopted only as a final rule can be accessed at https://www.faa.gov/about/office_org/headquarters_offices/apl/aee/noise/uas_noise_certification. The FAA is establishing a companion dedicated mailbox to allow inquiries and comments on final rules. This mailbox is not a docketed location for comments on notices of proposed rulemaking; those docketed rules remain on the regulations.gov website although the final rules are included in the FAA database for interested persons

to view the UA RPAs in one location. The e-mail address for the UA RPA mailbox is NoiseCertificationStandard@faa.gov.

For the aircraft model described in this rulemaking, the final rule adoption procedure has been used. The noise certification basis adopted here for the Zipline Zip aircraft is essentially similar to the noise certification basis adopted for the Matternet Inc. Model M2 aircraft (87 FR 5587, September 12, 2022).

Publication and effectivity of this rule

The Administrative Procedure Act (5 U.S.C. 551 et seq.) requires federal agencies to publish notices of substantive rules of general applicability, statements of general policy and interpretations of general applicability in the Federal Register (§552(a)(1)(D)). The APA recognizes rules of particular applicability (RPA), but requires publication only of "substantive rules of general applicability." Since this rule is an RPA that affects a single manufacturer and a single model of aircraft, this rule does not require publication in the Federal Register.

The Administrative Procedure Act also requires the publication or service of any substantive rule not less than 30 days before its effective date, except as otherwise provided by the agency for good cause found and published with the rule. (5 U.S.C. § 553(d)).

Delaying the effective date of this rule is unnecessary. This rule applies only to the applicant, and any delay in the effective date of this rule would serve only to delay the applicant's ability to complete the certification of its aircraft. Accordingly, the FAA finds that good cause exists to make this rule effective in less than 30 days.

III. Discussion: Zipline Zip

A. General

Zipline applied for type certification of its Zip aircraft on July 24, 2019. The aircraft is a fixed-wing airplane design UA with a maximum takeoff weight of 49.3 pounds and a proposed operating altitude of 400 feet or lower. To fulfill its statutory requirement under section 44715(a)(3), the FAA is adopting this set of noise certification standards that apply only to the Zip aircraft described in this rule, since no general noise standards exist that can be applied effectively to this aircraft.

This is an RPA that continues the efforts of the FAA to build a base of noise certification data that will result in rules of general applicability for UA in part 36. The FAA is building this base by certificating individual models of UA using noise standards that meet its statutory responsibility to promulgate noise rules that are economically reasonable, technologically practicable, and appropriate for the applicable aircraft.[1]

This rule presents only the noise certification basis for the Zipline Zip aircraft. The rule is not intended to affect the airworthiness certification of this aircraft model or present any operational approvals.[2] The FAA, in accordance with the applicable airworthiness standards and operating rules, makes those findings separately.

In certificating the subject aircraft, the FAA used the standard procedures for determining the aircraft's certification bases (noise and airworthiness). This is an iterative process of determining what regulations apply to the aircraft presented by the applicant, and accounts for any new or novel features of the aircraft. The FAA works

[1] The type certification basis of each aircraft is determined by the regulations in effect on the date of application for a type certificate.

[2] As is true for all noise certification, this rule neither assesses the environmental impacts of any eventual operation of the subject aircraft, nor constitutes any environmental review that may be required by the FAA before granting operational approval. Any such environmental review would be completed in advance of granting operational approval(s).

closely with the applicant to ensure that the applicant understands what standards apply, and what must be demonstrated during certification.

In the case of the Zipline Zip UA, the FAA determined that although the subject aircraft has some characteristics that are similar to a small helicopter that would be noise certificated under appendix J to part 36, the differences require noise certification test criteria and standards tailored to the size and features of the UA model. The FAA worked with Zipline to understand the features and expected operating environment of the aircraft to determine the appropriate modifications and additions to the limits and procedures needed to complete its noise certification basis. The results of the agency's assessments are presented in this rule. For persons unfamiliar with noise certification requirements, the rule text is annotated at the beginning of each paragraph to indicate similar requirements in part 36 appendix J. The requirements presented in this rule stand alone for certification of the Zipline Zip aircraft.

In addition to the data gathered for demonstrating compliance with part 36, Zipline agreed to conduct a supplemental test and give the resulting data to the FAA to inform the larger database of noise experience with UA. Data from the supplemental test are not part of the type or airworthiness certification basis of the aircraft and will not be evaluated against any noise limits or regulatory criteria for noise certification purposes.

B. Differences from generally applicable noise regulations

The FAA began its determination of the noise certification basis for the Zipline Zip aircraft using the current standards and procedures for small helicopters. To compensate for the novel aircraft design features, including the size, propulsion system, and proposed flight operations, the following new standards are included in the Zipline Zip noise certification basis:

1. The reference altitude for the level flyover test is 250 feet (rather than 492 feet in appendix J), item 6 in this rule. This lower reference altitude addresses the nominal altitude for this UA and the FAA determined it to be representative of the cruise altitude for this UA.
2. The applicable reference airspeed is: $V_R = 0.9V_H$, where V_H is the maximum forward controllable airspeed attainable by the aircraft in level flight at the maximum power level the motors can produce and the most critical configuration that produces the highest noise level. Although both speed and aircraft weight contribute to noise generation, the FAA does not have sufficient data regarding these two factors to know which dominates in UA designs such as the Zipline Zip.
3. The limit is 78 dB SEL[3] at the prescribed new reference level flyover altitude of 250 feet.

In the absence of historical data regarding most models of UA, the FAA began its analysis by using the existing noise limits in the regulations and extrapolating those limits to a lower weight aircraft tested at a lower altitude. The FAA used established limit data from the appendices (including A and J) to part 36 where practicable, and FAA applied accepted, well-known noise certification principles and adjustment methods in developing this rule. Since the Zipline Zip is a package delivery UA which will primarily operate in level flight, the FAA used as its starting point the simplified helicopter noise limit found in part 36 appendix J that applies to smaller helicopters (§ J36.305 (a)(2)). One key assumption of this method is

[3] SEL - Sound Exposure Level

that fundamental rotorcraft physics and associated noise are scalable for lighter weight UA. For the subject aircraft, the Stage 3 noise limit of appendix J was extrapolated to the maximum take-off weight (MTOW) to correspond to a 527 pound aircraft. A secondary noise adjustment was applied to account for the adjusted reference altitude of 250 feet for the Zipline Zip, rather than the 492-foot reference altitude in appendix J. These two adjustments account for the size and the expected operational altitudes of the Zipline Zip. These adjustments provide the basis for the constant 78 dB limit for the Zipline Zip.

This rule contains updated terminology, equipment references, recording standards, and relevant best practices that have become standard in the industry since appendix J was first adopted in 1992 and are used in current noise certifications. This rule may also contain minor differences from the prior RPA on which it is based to account for differences in the aircraft and updated references to which the applicant agreed.

This rule includes the requirement to create a test plan and have it approved by the FAA before any tests are conducted. This plan is used during certification testing but may be unfamiliar to newer certification applicants. An applicant seeking noise type certification must prepare a test plan when testing is required to demonstrate compliance with the regulations. The applicant should submit the test plan early enough to allow the FAA time to review and approve the test plan before the planned start of testing. A test plan typically contains descriptions of the aircraft, test equipment, calibration procedures, and test procedures. Tests conducted before a test plan is approved by the FAA may render that test data unacceptable for a demonstration of compliance with part 36.

IV. Regulatory Notices and Analyses

A. Regulatory Evaluation

This RPA is not subject to review under Executive Order 12866, Regulatory Planning and Review, as that Executive Order applies only to rules of general applicability.

B. Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (Public Law 96-354) (RFA) establishes "as a principle of regulatory issuance that agencies shall endeavor, consistent with the objectives of the rule and of applicable statutes, to fit regulatory and informational requirements to the scale of the businesses, organizations, and governmental jurisdictions subject to regulation." To achieve this principle, agencies are required to solicit and consider flexible regulatory proposals and to explain the rationale for their actions to assure that such proposals are given serious consideration. The RFA covers a wide range of small entities, including small businesses, not-for-profit organizations, and small governmental jurisdictions.

Agencies must perform a review to determine whether a rule will have a significant economic impact on a substantial number of small entities. If the agency determines that it will, the agency must prepare a regulatory flexibility analysis as described in the RFA. However, if an agency determines that a rule is not expected to have a significant economic impact on a substantial number of small entities, section 605(b) of the RFA provides that the head of the agency may so certify, and a regulatory flexibility analysis is not required.

This rule impacts only Zipline which is considered a small business based on the U.S. Small Business Administration (SBA) size standards. The SBA lists small business size standards based on the North American Industry Classification System (NAICS). NAICS code 336411 is titled "Aircraft Manufacturing," and includes the manufacture of unmanned and robotic aircraft. The SBA defines industries within this code to be small if they employ 1,500 employees or less.

The FAA expects this rule to generate small voluntary costs for Zipline to conduct tests and gather data. These would be one-time test costs representing a small portion relative to the overall costs of seeking of type certification. This rule would benefit Zipline by enabling a noise certification basis for it to complete the type certification it seeks. The FAA expects this rule would not have a significant economic impact on Zipline.

If an agency determines that a rulemaking will not result in a significant economic impact on a substantial number of small entities, the head of the agency may so certify under section 605(b) of the RFA. Therefore, based on the foregoing discussion, as provided in section 605(b), the head of the FAA certifies that this rulemaking will not result in a significant economic impact on a substantial number of small entities since only one entity is affected.

C. International Trade Impact

The Trade Agreements Act of 1979 (Public Law 96-39), as amended by the Uruguay Round Agreements Act (Public Law 103-465), prohibits Federal agencies from establishing standards or engaging in related activities that create unnecessary obstacles to the foreign commerce of the United States. Pursuant to these Acts, the establishment of standards is not considered an unnecessary obstacle to the foreign commerce of the

United States, so long as the standard has a legitimate domestic objective, such as the protection of safety, and does not operate in a manner that excludes imports that meet this objective. The statute also requires consideration of international standards and, where appropriate, that they be the basis for U.S. standards. The FAA has determined this rule would not present any obstacle to foreign commerce of the United States. In addition, this rule is not contrary to international standards since no international standards for UA noise certification exist.

D. Unfunded Mandates Assessment

Title II of the Unfunded Mandates Reform Act of 1995 (Public Law 104-4) requires each Federal agency to prepare a written statement assessing the effects of any Federal mandate in a proposed or final agency rule that may result in an expenditure of $100 million or more (in 1995 dollars) in any one year by State, local, and tribal governments, in the aggregate, or by the private sector; such a mandate is deemed to be a "significant regulatory action." The FAA currently uses an inflation-adjusted value of $155 million in lieu of $100 million. This rule does not contain such a mandate; therefore, the requirements of Title II of the Act do not apply.

E. Paperwork Reduction Act

The Paperwork Reduction Act of 1995 (44 U.S.C. 3507(d)) requires that the FAA consider the impact of paperwork and other information collection burdens imposed on the public. The FAA has determined that there is no new requirement for information collection associated with this RPA.

F. International Compatibility

The FAA remains actively involved in the International Civil Aviation Organization's (ICAO) Committee on Aviation Environmental Protection (CAEP) and

CAEP's Working Group 1 that addresses aircraft noise. Working Group 1 began activities to address noise from UA in 2013. There are at present no noise or other environmental standards for UA that have been adopted into ICAO Annex 16. The FAA has determined that there are no ICAO Standards and Recommended Practices that correspond to these regulations so as to require conformance.

There are ongoing UA noise standard developments by the European Union Aviation Safety Agency (EASA), and by the International Standard Organization (ISO). None of those standards are known to be intended for use in aircraft type certification for noise as is adopted here.

G. Environmental Analysis

FAA Order 1050.1F, Environmental Impacts: Policies and Procedures, identifies FAA actions that are categorically excluded from preparation of an environmental assessment or environmental impact statement under the National Environmental Policy Act of 1969 (42 U.S.C. 4321-4347), in the absence of extraordinary circumstances. The FAA has determined this rulemaking action qualifies for the categorical exclusion identified in paragraph 5-6.6 (d) (Categorical Exclusions for Regulatory Actions) for regulations since it is a rulemaking action that proscribes a certification test standard, and would not presume the acceptability of operation of any particular aircraft in any location. No extraordinary circumstances are involved.

V. Executive Order Determinations

A. Executive Order 13132, Federalism

The FAA has analyzed this rule under the principles and criteria of Executive Order 13132, Federalism. The agency has determined that this action would not have a

substantial direct effect on the States, or the relationship between the Federal Government and the States, or on the distribution of power and responsibilities among the various levels of government, and, therefore, would not have Federalism implications.

B. Executive Order 13211, Regulations that Significantly Affect Energy Supply, Distribution, or Use

The FAA analyzed this rule under Executive Order 13211, Actions Concerning Regulations that Significantly Affect Energy Supply, Distribution, or Use (May 18, 2001). The agency has determined that it would not be a "significant energy action" under the executive order and would not be likely to have a significant adverse effect on the supply, distribution, or use of energy.

VI. Additional Information

A. The Noise Certification Basis

In consideration of the foregoing, and under the authority of Title 49 of the United States Code, section 44715(a), the Federal Aviation Administration determines that the following standards and procedures apply as the noise certification basis of the Zipline Zip aircraft.

All statutory references in this rule refer to Title 49 of the United States Code. All regulatory references refer to Title 14 of the Code of Federal Regulations, part 21 or part 36 and its appendices, unless otherwise cited.

Noise Certification Requirements for the Zipline Zip Aircraft:

(1) General: The requirements and limitations of 14 CFR 36.3 apply to the Zipline Zip aircraft, except as described herein.

(a) **Limitations** (Reference § 36.5, as modified): Pursuant to 49 U.S.C. 44715(b)(4), the noise level in this rule has been determined to be as low as is

economically reasonable, technologically practicable, and appropriate for this aircraft. No determination is made that these noise levels are or should be acceptable or unacceptable for operation at, into, or out of, any airport, landing or launch pad, community, or any other environment that may be impacted or is sensitive to noise.

(b) **Acoustical Change** (Reference § 36.9, as modified): If, after type certification using the requirements stated herein, the aircraft incorporates a change in type design, the changed design is subject to an acoustical change analysis and approval in accordance with § 21.93(b). After such change in design, the aircraft may not subsequently exceed the noise limits specified in this rule.

(2) Noise Measurement (Reference § 36.801, as modified): The noise generated by the aircraft must be measured at the noise measuring point and under the test conditions prescribed in paragraphs (7) through (22) of this rule, or using an equivalent procedure approved by the FAA before testing. Any procedure not approved by the FAA before a test is performed is subject to disapproval and may require the aircraft to be retested using an approved procedure.

(3) Noise Evaluation (Reference § 36.803, as modified): The noise measurement data required by paragraph (2) of this rule must be obtained using the test procedures in paragraphs (7) through (24) of this rule, and:

(a) Corrected to the reference conditions contained in paragraphs (5) and (6) of this rule; and

(b) Evaluated using the procedures in paragraphs (25) through (27) of this rule, or using an FAA-approved equivalent procedure. Any procedure not approved

by the FAA before a test is performed is subject to disapproval and may require the aircraft to be retested using an approved procedure.

(4) Noise Limits (Reference § 36.805, as modified): Compliance with the noise limits prescribed in paragraphs (28) and (29) of this rule must be shown for this aircraft for which application for issuance of a type certificate in the special class is made under part 21.

(5) Reference Conditions - General (Reference part 36 appendix J, section J36.1, as modified): Paragraphs (6) through (29) of this rule prescribe the noise certification requirements for this aircraft including:

(a) The conditions under which each noise certification test must be conducted and the measurement procedure that must be used to measure the aircraft noise during the test;

(b) The procedures that must be used to correct the measured data to the reference conditions, and to calculate the noise evaluation quantity designated as the A-weighted Sound Exposure Level (SEL, denoted by symbol L_{AE}); and

(c) The noise limit with which compliance must be shown.

(6) Reference Conditions – Test (Reference part 36 appendix J, section J36.3, as modified). The FAA witness on site during testing may approve modifications to the requirements of paragraphs (b) and (c) of this section, as considered reasonable and appropriate for the conditions encountered during testing. Any such approved modifications must be included in the applicable reports required by this rule for the aircraft:

(a) Meteorological Conditions - The following are the noise certification reference atmospheric conditions that are assumed to exist from the surface to the aircraft altitude:

i. Sea level pressure of 2,116 pounds per square foot (76 centimeters of mercury);

ii. Ambient temperature of 77 degrees Fahrenheit (25 degrees Celsius);

iii. Relative humidity of 70 percent; and

iv. Zero wind.

(b) Reference test site. The reference test site is flat and without line-of-sight obstructions, including any area across the flight path that is long enough to encompass the 15 dB down points of the A-weighted time history.

(c) Level flyover reference profile. The reference flyover profile is a level flight, 250 feet (76.2 meters) above ground level as measured at the noise measuring station under the following reference profile conditions:

i. The applicable reference airspeed is $V_R = 0.9V_H$, where V_H is the maximum forward controllable airspeed attainable by the aircraft in level flight at the maximum power level the motors can produce and the most critical configuration that produces the highest noise level.

ii. The reference flyover profile has a linear flight track and passes directly over the noise monitoring station. The reference airspeed and operating RPM is stabilized and maintained throughout the measurement period (15 dB-down points).

iii. If different configurations result in different reference airspeeds, then each configuration must be tested.

(7) Noise Measurement Procedures -- General (Reference part 36, appendix J, section J36.101(a), as modified): Paragraphs (8) through (10) of this rule prescribe the conditions under which the aircraft noise certification tests must be conducted, and the measurement procedures that must be used to measure the aircraft noise during each test.

(8) Test site requirements (Reference: part 36, appendix J, section J36.101(b), as modified):

(a) The noise measuring station must be surrounded by terrain having no excessive sound absorption characteristics, such as might be caused by thick, matted, or tall grass, shrubs, wooded areas, or loose soil. Grass is acceptable if mowed to 3 inches or less in a 25 foot radius around any sound measuring stations.

(b) During the period when the flyover noise measurement is within 10 dB of the maximum A-weighted sound level, no obstruction that significantly influences the sound field from the aircraft may exist within a conical space above the noise measuring position (the point on the ground vertically below the microphone). The cone is defined by an axis normal to the ground and by half-angle 80 degrees from this axis.

(9) Weather restrictions (Reference: part 36, appendix J, section J36.101(c), as modified): Each test must be conducted under the following atmospheric conditions:

(a) No rain or other precipitation.

(b) Ambient air temperature between 36 degrees and 95 degrees Fahrenheit (2 degrees and 35 degrees Celsius), inclusively, and relative humidity between 20 percent and 95 percent inclusively, except that testing may not take place where combinations of temperature and relative humidity result in a rate of atmospheric attenuation greater than 12 dB per 100 meters (36.6 dB per 1,000 feet) in the one-third octave band centered at 8 kilohertz (kHz).

(c) Wind velocity that does not exceed 10 knots (19 km/h) and a crosswind component that does not exceed 5 knots (9 km/h). The wind must be determined using a continuous averaging process of no greater than 30 seconds.

(d) Measurements of ambient temperature, relative humidity, wind speed, and wind direction must be made between 10 feet (3 meters) and 33 feet (10 meters) above the ground. Unless otherwise approved by the FAA, ambient temperature and relative humidity must be measured at the same height above the ground.

(e) No anomalous wind conditions (including turbulence) or other anomalous meteorological conditions that could significantly affect the noise level of the aircraft when the noise is recorded at the noise measuring station.

(f) If the measurement site is within 6,560 feet (2,000 meters) of a fixed meteorological station (such as those found at airports or other facilities), the weather measurements reported at that station may be used for temperature, relative humidity and wind velocity, when approved by the FAA before the test is conducted. The use of measurements reported at a fixed meteorological

station, if not approved by the FAA before a test is performed, may cause the test to be disapproved and require that the aircraft be retested.

(10) Aircraft test procedures (Reference part 36, appendix J, section J36.101(d), as modified)**:**

(a) The aircraft test procedures and noise measurements must be conducted and processed in a manner that yields the noise evaluation measure designated $L_{AE,}$ as defined in paragraph (18) of this rule.

(b) The aircraft height relative to the noise measurement point sufficient to make corrections required in paragraph (27) of this rule must be determined by an FAA-approved method that is independent of normal flight instrumentation, such as a Differential Global Positioning System (DGPS), or photographic scaling techniques. The aircraft position in three dimensions relative to the microphone must be monitored and recorded at all times during the test and data collection, with correlation via time synchronization to the acoustic noise data collection. The accuracy of the aircraft location system, and all sources of inaccuracy, along with possible error introduction when correlating to measured and recorded noise (inaccuracies of timing devices and methods), must be determined and reported. A description of the aircraft location system and its accuracy must be included as part of the noise test plan required by paragraph (31) of this rule, and approved by the FAA before use.

(c) If an applicant demonstrates that the design characteristics of the aircraft would prevent flight from being conducted in accordance with the reference test conditions prescribed in paragraph (6) of this rule, then the applicant may request a variance in reference test conditions to be used. Any variance from

standard reference test conditions is limited to that required for the subject aircraft design characteristics that make compliance with the reference test conditions impossible.

(11) Flyover Test Conditions (Reference part 36, appendix J, section J36.105(a), as modified): Paragraphs (12) through (15) of this rule prescribe the flight test conditions and allowable random deviations for flyover noise tests conducted to demonstrate compliance with this rule.

(12) Level flight height and lateral path tolerances (Reference part 36, appendix J, section J36.105(b), as modified): A test series must consist of at least six flights. The number of level flights made with a headwind component must be equal to the number of level flights made with a tailwind component over the noise measurement station:

(a) In level flight and in cruise configuration;

(b) At the test height above the ground level over the noise measuring station as defined in paragraph (6)(c) of this rule. For the selected height, the vertical tolerance of this height should be ± 10% value; and

(c) Within ±10 degrees from the zenith.

(13) Airspeed and Controls (Reference part 36, appendix J, section J36.105(c), as modified): Each flyover noise test flight must be conducted:

(a) At the reference airspeed specified in paragraph (6)(c)(i) of this rule; and

(b) With the flight controls stabilized during the period when the measured aircraft noise level is within 10 dB of the maximum A-weighted sound level (L_{Amax}).

(14) Aircraft weight (Reference part 36, appendix J, section J36.105(d), as modified): For the weight at which noise certification is requested, the aircraft test weight for each flyover test series must be specified for:

(a) MTOW (inclusive of payload); and

(b) Empty weight (no payload).

(15) Flyover height adjustment (Reference part 36, appendix J, section J36.105(e), as modified): If ambient noise at the measurement station, measured in accordance with paragraphs (17) through (22) of this rule, is found to be within 15 A-weighted decibels (dB(A)) of the A-weighted aircraft noise level (L_{Amax}), measured at the same location, the applicant may request the FAA approve an alternate flyover height. If an alternate flyover height is approved, the results must be adjusted to the reference flyover height specified in paragraph (6)(c) of this rule using an FAA-approved method.

(16) Supplemental test conditions –These are supplemental tests to collect data assessment of community noise impacts of takeoff, landing and delivery conditions, and to inform future noise standards. These supplemental tests do not require compliance with a noise limit and does not affect the noise certification findings for the subject aircraft.

The aircraft is required to operate to its standard range of operating conditions – takeoff, landing and delivery in accordance with subparagraphs (a) through (f) of this paragraph. The measurements will be recorded with a ground plane microphone setup in accordance with 14

CFR part 36 appendix G, section G36.107(a).

(a) A complete test condition series consist of at least 3 valid passes over the microphone.

(b) Takeoff condition (under launch rail path): For the takeoff measurement, the aircraft will be at MTOW, inclusive of maximum payload weight of cargo. The microphone will be located at a distance 150 feet away from aircraft's starting launch position that is immediately under and in line with the takeoff launch path. Start recording prior to aircraft takeoff (launch) event. All normal operations of launch crew and equipment that are a part of the launching sequence for each flight will be included in the noise measurement/sound recording.

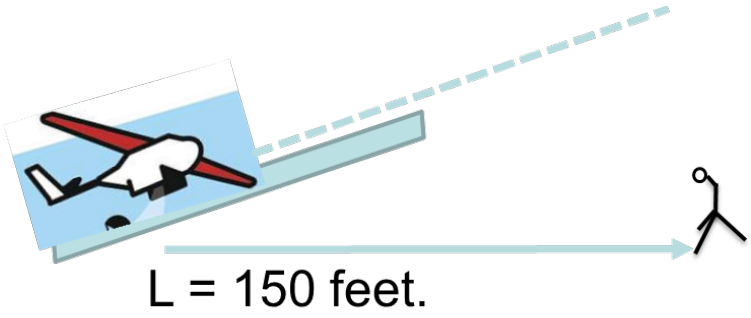

Figure 1 Sketch of supplemental takeoff condition. L = 150 ft.

(c) Landing condition (ahead of and aligned under the recovery towers path): For the landing measurement, the aircraft must be at empty weight. The microphone will be located at a distance 150 feet ahead of landing (capture) position and along the UA landing path. All normal operations of recovery crew and equipment that are a part of the recovery sequence for each flight will be included in the noise measurement/sound recording. Start recording prior to aircraft landing (capture) event.

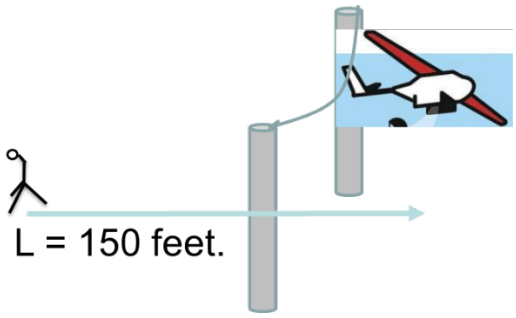

Figure 2 Sketch of supplemental landing (capture) condition. L = 150 ft.

(d) Delivery condition (under the delivery point): For the delivery measurement, the microphone is located 60 feet (18 m) vertically below the delivery flight path inflection point. The UA will fly its approach profile (segment AD), release the package, and initiate its climb profile (segment DC) as shown in the delivery procedure below. Delivery condition will be performed at MTOW until the payload is dropped before climb-out.

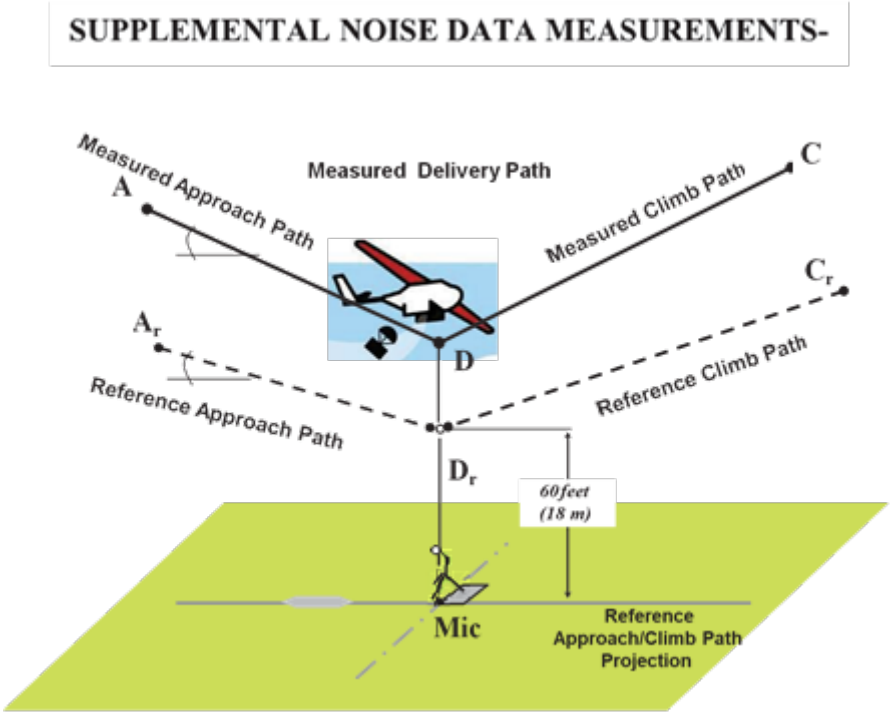

Figure 3 Sketch of supplemental delivery condition with reference path. D_r = 60 ft.

(e) For both supplemental test condition series, the noise measurements are to be recorded to produce the values of the sound exposure level (L_{AE}) as prescribed in paragraph (18) of this rule.

The tolerances of the delivery condition are +/- 6 ft of target height, +/- 30 ft longitudinally, and +/- 10 degrees laterally of the zenith. A lateral tolerance of +/- 10 degrees from the zenith is also applicable for takeoff and landing conditions

(17) Measurement of aircraft noise received on the ground – General (Reference: part 36, appendix J, section J36.109(a), as modified): Aircraft noise measurements made for the purpose of noise certification in accordance with the requirements of this rule must be obtained using:

(a) The noise evaluation metric prescribed in paragraph (18) of this rule;

(b) Acoustic equipment that meets the specifications prescribed in paragraphs (19) and (20) of this rule; and

(c) The calibration and measurement procedures prescribed in paragraphs (21) and (22) of this rule.

(18) Measurement of aircraft noise received on the ground – Noise unit definition (Reference part 36, appendix J, section J36.109(b), as modified):

(a) The sound exposure level, as expressed in LAE, is defined as the level, in decibels, of the time integral of squared A-weighted sound pressure (P_A) over a given time period or event, with reference to the square of the standard reference sound pressure (P_0) of 20 micropascals and a reference duration of one second.

(b) The sound exposure level in units of decibels (dB) is defined by the expression:

$$L_{AE} = 10\ \log_{10}\frac{1}{T_0}\int_{t_1}^{t_2}\left(\frac{P_A(t)}{P_0}\right)^2 dt\ \text{(dB)}$$

Where T_0 is the reference integration time of one second and (t_2-t_1) is the integration time interval.

(c) The integral equation of paragraph (18)(b) can also be expressed as:

$$L_{AE} = 10\ \log_{10}\frac{1}{T_0}\int_{t_1}^{t_2} 10^{0.1L_A(t)}dt\ \text{(dB)}$$

Where $L_A(t)$ is the time varying A-weighted sound level.

(d) The integration time (t_2-t_1) in practice must not be less than the time interval during which $L_A(t)$ first rises to within 10 dB(A) of its maximum value (L_{Amax}) and last falls below 10 dB(A) of its maximum value.

(19) Measurement of Aircraft Noise Received on the Ground – Measurement System (Reference part 36, appendix J, section J36.109(c), as modified):

(a) Acoustical measurement system instrumentation must be equivalent to the following and approved by the FAA:

i. A microphone system with frequency response that is compatible with the measurement and analysis system accuracy prescribed in paragraph (20) of this rule;

ii. Tripods or similar microphone mountings that minimize interference with the sound energy being measured; and

iii. Recording and reproducing equipment with characteristics, frequency response, and dynamic range that are compatible with the response and accuracy requirements of paragraph (20) of this rule.

(b) The calibration and checking of measurement systems must be accomplished in accordance with the procedures described in part 36, appendix A, section A36.3.9.

(20) Measurement of Aircraft Noise Received on the Ground – Sensing, recording, and reproducing equipment (Reference part 36, appendix J, section J36.109(d), as modified):

(a) The sound pressure time-history (audio) signals obtained from aircraft flyovers under this paragraph must be recorded digitally at a minimum sample rate of 44 kHz for a minimum bandwidth of 20 hertz (Hz) to 20 kHz, and encoded using a minimum of 16 bit linear PCM (or equivalent) during analog to digital conversion. Digital audio recording must also meet the additional requirements specified in part 36, appendix A, section A36.3.6 "Recording and Reproducing Systems."

(b) The L_{AE} value from each flyover test flight condition may be determined directly from an integrating sound level meter that meets the specifications of International Electrotechnical Commission (IEC) Standard 61672-1 (2013) for a Class 1 instrument set at "slow" response.

(c) The acoustic signal from the aircraft, along with the calibration signals specified in paragraph (21) and the background noise signal required by paragraph (22) of this rule, must be recorded in a digital audio format as specified in paragraph (20)(a) of this rule for subsequent analysis for an integrating sound level meter identified in paragraph (20)(b) of this rule. The record/playback system must conform to the requirements prescribed in part 36, appendix A, section A36.3.6 "Recording and Reproducing Systems."

The recorder must comply with the specifications of IEC standard 61265 2nd edition (2018).

(d) The characteristics of the complete system must meet the specifications of IEC standard 61672-1 for the microphone, amplifier, and indicating instrument characteristics.

(e) The response of the complete system to a plane, progressive wave of constant amplitude must lie within the tolerance limits specified for Class 1 instruments in IEC standard 61672-1 for weighting curve "A" over the frequency range of 45 Hz to 20 kHz.

(f) A windscreen must be used with the microphone during each measurement of the aircraft flyover noise.

(21) Measurement of Aircraft Noise Received on the Ground – Calibrations

(Reference part 36, appendix J, section J36.109(e), as modified):

(a) For the aircraft acoustic signal recorded for subsequent analysis, the measuring system and components of the recording system must be calibrated as prescribed in Title 14 CFR, part 36, appendix A.

(b) If the aircraft acoustic signal is measured directly using an integrating sound level meter:

i. The overall sensitivity of the measuring system must be checked before and after the series of flyover tests and at intervals (not exceeding a two-hour duration) during the flyover tests using an acoustic calibrator generating a sinusoidal signal at a known sound pressure level and at a known frequency.

ii. The performance of equipment in the system is considered satisfactory if, during each day's testing, the variation in the measured value for the acoustic calibrator does not exceed 0.5 dB. The L_{AE} data collected during the flyover tests must be adjusted to account for any variation in the calibration value.

iii. A performance calibration analysis of each piece of calibration equipment, including acoustic calibrators, reference microphones, and voltage insertion devices, must have been made during the six calendar months preceding the beginning of the aircraft flyover series. Each calibration must be traceable to the National Institute of Standards and Technology.

(22) Measurement of Aircraft Noise Received on the Ground – Noise measurement procedures (Reference part 36, appendix J, section J36.109(f), as modified):

(a) The microphone must be of a pressure-sensitive capacitive type designed for nearly uniform grazing incidence response. The microphone must be mounted with the center of the sensing element 4 feet (1.2 meters) above the local ground surface and must be oriented for grazing incidence such that the sensing element (diaphragm) is substantially in the plane defined by the nominal flight path of the aircraft and the noise measurement station. A microphone that satisfies the requirements of this paragraph must be used when determining compliance with the noise limit prescribed in paragraph (29) of this rule.

(b) For each aircraft acoustic signal recorded for subsequent analysis, the frequency response of the electrical system must be determined at a level within 10 dB of the full-scale reading used during the test.

(c) The background noise, including both ambient acoustical sound present at the microphone site and electrical noise of the measurement systems, must be determined in the test area and the system gain set at levels which will be used for aircraft noise measurements. If aircraft sound levels do not exceed the background sound levels by at least 15 dB(A), flyovers at an FAA-approved lower height may be used; the results must be adjusted to the reference measurement point by an FAA-approved method.

(d) When an integrating sound level meter is used to measure the aircraft noise, the instrument operator must monitor the continuous A-weighted (slow response) noise levels throughout each flyover to ensure that the A-weighted sound exposure level (L_{AE}) integration process includes, at minimum, all of the noise signal between the L_{Amax} and the 10 dB down points in the flyover time history. The instrument operator must note the actual dB(A) levels at the start and stop of the L_{AE} integration interval and document these levels along with the value of L_{Amax} and the integration interval (in seconds) for inclusion in the noise data submitted as part of the reporting requirements in paragraph (23) of this rule.

(23) Data Reporting – General (Reference part 36, appendix J, section J36.111(a), as modified): Data representing physical measurements, and corrections to that measured data, including corrections to measurements for equipment response

deviations, must be recorded in permanent form and appended to the test reports required by this rule. Each correction is subject to FAA approval.

(24) Data Submission (Reference part 36, appendix J, section J36.111(b), as modified): After the completion of all certification tests required by this rule, the following must be submitted to the FAA:

(a) A test report containing the following:

(i) Measured and corrected sound levels obtained with equipment conforming to the standards prescribed in paragraphs (17) through (22) of this rule;

(ii) A description of the equipment and systems used for measurement and analysis of all acoustic, aircraft performance and flight path, and meteorological data;

(iii) The atmospheric environmental data required to demonstrate compliance with this rule, as measured throughout the test period;

(iv) Conditions of local topography, nearby ground cover (if any), or events that may have interfered with a sound recording;

(v) The following aircraft information:

A) Type, model, and serial numbers, if any, of aircraft, engine(s) and rotor(s) and/or propellers tested;

B) Gross dimensions of aircraft, location of engines or motors, rotors or propellers, number of blades for each rotor or propeller, and the range of rotational speeds of the rotors;

C) MTOW at which certification under this rule is requested;

D) Aircraft configuration, including landing gear positions;

E) Reference airspeed of $0.9V_H$;

F) Aircraft gross weight for each test run;

G) Indicated and true airspeed for each test run; if indicated and true airspeed for each run are not available, then ground speed as measured from a DGPS, or from an alternate method, may be approved by the FAA;

H) Ground speed, if measured, for each run;

I) Aircraft engine performance as determined from aircraft instruments and manufacturer's data; and

J) Aircraft flight path above ground level, referenced to the microphone position of the noise measurement station, in feet, determined using an FAA-approved method that is independent of normal flight instrumentation, such as DGPS or photo scaling techniques at the microphone location.

(vi) Aircraft position and performance data necessary to make the adjustments prescribed in paragraph (27) of this rule and to demonstrate compliance with the performance and position restrictions prescribed in paragraphs (11) through (16) of this rule.

(b) All of the recorded audio data from all phases of all flight tests used to demonstrate compliance with this rule.

(c) All recordings and data collected during the measurement activity required by paragraph (16) of this rule. These data will not affect the outcome of this certification findings intended to demonstrate compliance with this rule and may be submitted separately from data that affects certification.

(25) Noise Evaluation and Calculations – Noise Evaluation Expressed in L_{AE} (Reference: part 36, appendix J, section J36.201, as modified): The noise evaluation measure must be expressed as the L_{AE} in units of dB(A) as prescribed in paragraph (18) of this rule. The L_{AE} value for each flyover may be determined directly using an integrating sound level meter. Specifications for the integrating sound level meter and requirements governing the use of such instrumentation are prescribed in paragraphs (17) through (22) of this rule.

(26) Noise Evaluation and Calculations – Calculation of Noise Levels (Reference part 36, appendix J, section J36.203, as modified)**:**

(a) To demonstrate compliance with the noise level limits specified in paragraph (29) of this rule, the L_{AE} noise levels from each valid flyover, corrected as necessary to reference conditions in accordance with paragraph (27) of this rule, must be arithmetically averaged to obtain a single L_{AE} dB(A) mean value for each flyover series. No individual flyover run may be omitted from the averaging process, unless approved by the FAA.

(b) The minimum sample size acceptable for the aircraft flyover certification measurements is six. The number of samples must be sufficient to establish statistically a 90 percent confidence limit that does not exceed ±1.5 dB(A).

(c) All data used and calculations performed under this paragraph, including the calculated 90 percent confidence limits, must be documented and provided in accordance with the data reporting and submission requirements of paragraphs (23) and (24) of this rule.

(27) Data Correction Procedures (Reference part 36, appendix J, section J36.205, as modified):

(a) When certification test conditions measured in accordance with paragraphs (7) through (23) of this rule differ from the reference test conditions prescribed in paragraph (6) of this rule, appropriate adjustments must be made to the measured noise data in accordance with the methods set out in paragraphs (27)(b) of this rule. At minimum, appropriate adjustments in accordance with paragraph (27)(b) of this rule must be made for off-reference altitude.

(b) The adjustment for off-reference altitude may be approximated from:

$$< delta > J1 = 12.5 \log_{10}(H_T/250) \text{ (dB)}$$

Where <delta>J1 is the quantity in decibels that must be algebraically added to the measured L_{AE} noise level to correct for an off-reference flight path, H_T is the height, in feet, of the test aircraft when directly over the noise measurement point, and the constant (12.5) accounts for the effects on spherical spreading and duration from the off-reference altitude.

(c) All data used and calculations performed under this paragraph must be documented and submitted in accordance with paragraphs (23) and (24).

(28) Noise Limit Compliance - Noise Measurement, Evaluation, and Calculation (Reference part 36, appendix J, section J36.301, as modified): In demonstrating compliance with this rule, the aircraft noise levels must be measured, evaluated, and calculated in accordance with paragraphs (7) through (27) of this rule.

(29) Noise Limit (Reference part 36, appendix J, section J36.305, as modified): The calculated noise levels of the aircraft, at the measuring point described in paragraphs (7) through (10) of this rule, must be shown to not exceed 78.0 dB L_{AE} at the reference altitude of 250 feet.

(30) Manuals, Markings, and Placards (Reference part 36 §§ 36.1501 and 36.1581, as modified):

(a) All procedures, weights, configurations, and information or data used to obtain the certified noise levels required to demonstrate compliance with this rule, including equivalent procedures used for flight, testing, and analysis, must be approved by the FAA.

(b) Noise levels achieved during type certification must be included in the approved portion of each Unmanned Aircraft Flight Manual for the subject aircraft. If an Unmanned Aircraft Flight Manual is not approved, the procedures and information must be furnished in a combination of manual material, markings, and placards approved by the FAA. The noise level information that must be included is as follows:

i. The noise level information must be one value for flyover as defined and required by these specifications; the value is determined at the maximum reference speed, weight and configuration in accordance with paragraph (6)(c) of this rule. The noise level value must also indicate the series from which it was determined.

ii. If supplemental operational noise level information is included in the approved portion of the Unmanned Aircraft Flight Manual, it must be segregated, identified as information that is provided in addition to the certificated noise levels, and clearly distinguished from the information required by paragraph (30)(b)(i) of this rule.

iii. The following statement must be included in each approved manual near the listed noise level:

No determination has been made by the Federal Aviation Administration that the noise levels of this aircraft are or should be acceptable or unacceptable for operation at, into, or out of any location or environment that may be affected by operational noise.

(31) Test Plan Preparation and Approval: Prior to conducting any testing and data collection required by this rule, the applicant must prepare a test plan and obtain approval of it from the FAA's Aircraft Certification Service, Policy & Standards Division (P&S), or another FAA employee designated by the P&S Division.

(32) Test Witnessing: The FAA P&S, or another FAA employee designated by the P&S Division, must witness the test and data collection required by this rule for the results to be valid for certification. Other acoustic focals from FAA's Aircraft Certification Office and Acoustic Engineer(s) from the Office of Environment and Energy or US DOT Volpe National Transportation Systems Center may also be present to observe the tests.

(33) Test Report Preparation and Approval: The applicant must prepare a report that includes all of the findings and data required under this rule. The report must be approved by the FAA P&S Division, or another FAA employee designated by the P&S Division, as a part of the aircraft certification record.

Issued in Washington, D.C. on July 3, 2023.

KEVIN W. WELSH

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Kevin Welsh

Executive Director, Office of Environment and Energy