



U.S. Department
of Transportation
Volpe National
Transportation
Systems Center

Memorandum

Subject: INFORMATION:

Date: 18AUG2017

**Volpe Aircraft Noise Certification Software & Methodology Validation/Audit
General Information, Data Submittal Guidelines, and Process Details;
Letter Report V324-FB48B3-LR2**

From: Dave Read, IT Specialist, Acoustics, Volpe Center,
Environmental Measurement and Modeling Division

Reply to
Attn. of: V324

To: Rebecca Cointin, Manager, Noise Division, FAA/AEE-100
and U.S. Aircraft Noise Certification Applicants

As required by Federal Aviation Administration (FAA) Order 8110.4C: "Type Certification Process" (most recently revised as "Change 5", 20 December, 2011), the Volpe Center Acoustics Facility (Volpe), in support of the FAA Office of Environment and Energy (AEE), performs audits of aircraft noise certification applicants' software and methodologies to ensure conformance with the requirements and specifications of Federal Regulation Title 14 part 36 (Part 36). These audits are executed as "validations" of applicants' software, instrumentation and procedures.

In order to effectively validate the software and methodology used by an applicant for aircraft noise certification, Volpe requests that the applicant provide detailed information and datasets, as described in the attached documents. Volpe will evaluate the applicant's methodology to determine whether it is in conformance with the specifications and requirements of Part 36, and will attempt to emulate the applicant's process. The results will be compared with those of the applicant to verify that the applicant's correction, calculation and adjustment procedures are valid. Once the validation process is completed, Volpe will generate a validation report to be submitted to AEE, who will then make an approval determination. It should be noted that Volpe has no authority to approve applicants' use of software or methodology for aircraft noise certification.

Currently, Volpe is performing these validations only for certification performed under Appendix A of Part 36 (jets, heavy props and helicopters). For other types of aircraft, Volpe

advises AEE, FAA Noise Certification Specialists (NCSs), and Aircraft Certification Offices (ACOs) on instrumentation and procedures used for noise certification.

In addition to the **primary software & methodology validation**, separate validations are performed for **noise measurement and analysis instrumentation systems**, and for **DGNSS (DGPS) tracking systems**. Applicants should note that validation of particular instrumentation for one applicant does not universally apply – each applicant must submit to validation of their instrumentation system, including evaluation of formalized documentation (such as an individualized operator manual or procedures report) for setup and operation of the instrumentation by the applicant. This may sometimes result in individual validation reports for instrumentation components and for applicant procedures related to those components.

Supplemental validations are performed for various individual equivalent procedures (such as a high-altitude jet source noise correction) or for additional capabilities in applicant software not previously validated for a particular applicant (such as for use of time-extrapolation when previously only frequency-extrapolation was validated, or for use of the Integrated Procedure when only the Simplified Procedure was previously validated.)

Re-validations are performed as needed for either:

- a. Changes to applicant software and/or methodology; or
- b. Changes to regulations or FAA policy that require new data comparisons; or
- c. When Volpe and FAA determine that a substantial time interval has passed since the previous validation exercise, justifying a re-validation due to improvements in state-of-practice and validation techniques.

Applicants should note that Volpe has established a set of detailed requirements for the data sets to be supplied, which in some cases exceed the reporting requirements for certification. This is necessary in order for Volpe to most accurately duplicate the applicant's procedures and to obtain meaningful results for evaluation. Complete data sets are required for at least three representative events: one each for approach, takeoff, and lateral-takeoff types for fixed-wing aircraft, and one each for approach, takeoff, and level flyover for rotorcraft (helicopters and tiltrotors). A complete sideline microphone data set is also required for at least one of the rotorcraft events. In addition to the listed information, the applicant should provide completed copies of the attached data forms, with information for each of the events. Data files should be provided in Excel or ASCII comma-separated-value (CSV) format.

The validation process is typically iterative in nature, and Volpe may request additional data sets from an applicant as the validation progresses.

If you have any comments or questions, please do not hesitate to contact me.

Attachments:

1. Data Submittal Instructions;
2. Dataset ID form;
3. Data Submittal Forms & Checklist;
4. Illustrative Figures; and
5. List of Resources.

cc:

M. Marsan, FAA, AEE-100
S. Liu, FAA, AEE-100
B. Conze, FAA (TADNCS), ANM-112
C. Cutler, Volpe, V324
C. Roof, Volpe, V324
C. Reherman, Volpe, V320
G. Fleming, Volpe, V320



Certification Validation Dataset Identification

For fixed-wing aircraft data.

APPLICANT _____

TEST DATE (MM/DD/YY) _____

AIRCRAFT DESIGNATION _____

Validation Package Reference Number		Data Set	Description	File Name		
				Takeoff	Lateral Takeoff	Approach
2		Flow Diagram	A flow diagram and/or description of measurement, analysis and adjustment systems, including system characteristics. Please identify which software modules perform each individual portion of the process.			
3		Raw Test-Day Noise Data	An uncorrected, contiguous, one-third octave SPL time-history for each event (ANSI/ISO bands 17-40, nominal center frequencies of 50 Hz to 10 kHz, inclusive, with records fully-encompassing the EPNL noise duration, the limits of which are defined as the 10 dB-down points in the PNLT time-history).			
4		Pre-detection background noise	A one-third octave spectrum of SPLs representing the average pre-detection noise, including the ambient noise conditions at the test site, and active electronic instrumentation noise floor (one for each event and site combination submitted).			
5		Post-detection background noise	A one-third octave spectrum of SPLs representing the post-detection noise at the sensitivity settings at which the individual event was processed (one for each event/site/system combination submitted). Note that post-detection noise is non-additive, and represents minimum levels below which measured values should be considered to be not valid.			
6		Meteorological Data	Meteorological data (i.e., temperature and relative humidity) versus altitude and time (per event) as used in processing for determining average test day speed of sound, atmospheric absorption, etc. A description of the meteorological data should be supplied, specifying any post-processing that was performed (such as smoothing, layering, time interpolation or altitude extrapolation) on the measured data prior to reporting. At a minimum, the temperature and humidity measured at 10 meters and at aircraft height should be supplied for each event.			
7		Aircraft Position Data	Aircraft position and performance data (TSPI - Time Space Position Information) for each event, including XYZ coordinates referenced to the centerline microphone location. A description of the tracking data should be supplied, specifying any post-processing that was performed (such as smoothing, curve-fitting, straight-line approximation, etc.) on the measured data prior to reporting.			
8	a	System response corrs	System corrections for deviation from flat frequency response (based on pink noise, swept-sine, or discrete-sine tone testing).			
	b	Pressure-response and free field sensitivity	Microphone pressure-response and free-field sensitivity corrections (including incidence-dependent corrections over a range of angles, if applicable).			
	c	Windscreen insertion effects	Microphone wind screen insertion-effects corrections.			
	d	Calibration Drift	Field calibration "drift" corrections.			
	e	Environmental calibrator corrections	Environmental corrections to Calibrator output level, such as those for pressure, temperature, humidity, and coupler volume.			
	f	System gain-change	System gain-change correction, for intentional differences in system sensitivity between calibration and aircraft noise measurement.			
	g	Other corrections	Other corrections, including source noise adjustments such as the high-altitude site jet source noise adjustment.			



Certification Validation Dataset Identification

For fixed-wing aircraft data.

11		Processed aircraft noise geometry data	If reconstruction is performed using time and/or frequency extrapolation, or if the "Integrated" Procedure is used for adjustment to reference conditions, a time-history of processed aircraft noise geometry (TXYZ emission coordinates, sound emission angle, and sound propagation distance relative to the microphone, at time of emission for each spectrum record within the noise duration) should be provided. Otherwise, such noise geometry information should be provided for at least the PNLTM record.				
		Layered atmospheric absorption	If atmospheric layering is performed, a table of atmospheric absorption coefficients ("alphas") for each layer, in dB per 100 meters or dB per 1000 feet should be provided for each event.				
		Cumulative test-day alphas	A spectrum (or series of spectra) for each event of cumulative test-day atmospheric absorption coefficients, in dB per 100 meters or dB per 1000 feet, should be provided.				
		Adjusted, as-measured 1/3 OB SPL time-history	For each event, provide a time-history of test-day "adjusted, as-measured", contiguous, one-third-octave-band data records along with calculated PNL, and PNLT values, and frequency band for maximum tone correction for each spectrum. Additionally, the test-day EPNL, band-sharing adjustment, and timestamp of PNLTM record should be included. The PNLTM record, the first and last 10 dB-down records, and any secondary peaks within 2 dB of PNLTM should also be identified.				
		Reference atmospheric absorption coefficients	The values used for reference condition atmospheric absorption coefficients in dB per 100 Meters or dB per 1000 feet, should be provided.				
	19	g - ii	Contiguous, reference 1/3 OB SPL time-history	For the Simplified Procedure ; for PNLTM and any records within 2 dB of PNLTM, a time-history of reference condition one-third-octave-band data records with calculated reference condition PNL_R , $PNLT_R$, and maximum tone correction frequency band.			
	20	c	Contiguous, reference 1/3 OB SPL time-history	For the Integrated Procedure ; a time-history of reference condition $SPL_{R,S}$, (one-third-octave-band data) with calculated PNL_R , $PNLT_R$, maximum tone correction frequency, and the calculated effective duration time for each record.			
d		Reference noise geometry time-history	For the Integrated Procedure ; a time-history of reference noise geometry (i.e., reference slant range $[SR_R]$; and reference TXYZ emission coordinates).				



U.S. Department
of Transportation
**Volpe National
Transportation
Systems Center**

Applicant Software & Methodology Validation Data Submittal

For fixed-wing aircraft data.

Form 1

MEASUREMENT & ANALYSIS

APPLICANT _____

TEST DATE (MM/DD/YY) _____

AIRCRAFT DESIGNATION _____

Site ID (Centerline, Left Sideline, Right Sideline, etc.)			
Site Coordinates: Distances in Feet Relative to Centerline microphone site (See Figure 1)	X	[X _{MIC}]	
	Y	[Y _{MIC}]	
	Z	[Z _{MIC}]	
Microphone Height (Feet AGL)		[H _{MIC}]	
Site Elevation (Feet MSL)			
Mic. Orientation re: Flight Path (ie: grazing, normal to CPA, normal to overhead, etc.)			
Microphone Manufacturer & Model			
Windscreen Manufacturer & Model			
Recorder Manufacturer & Model			
Calibrator Manufacturer & Model			
Analyzer Manufacturer & Model			
Analyzer Averaging Time Period			
Analyzer Avg. Mode (linear/exp.)			
Tone Correction Lower Limit (Hz)			
Other Adjustment(s)			



U.S. Department
of Transportation
**Volpe National
Transportation
Systems Center**

Applicant Software & Methodology Validation Data Submittal

For fixed-wing aircraft data.

Form 2

FLIGHT PERFORMANCE & OPERATION

APPLICANT _____

TEST DATE (MM/DD/YY) _____

AIRCRAFT DESIGNATION _____

Event ID			
Site ID			
Event Type (Takeoff, Approach, Lateral Takeoff)			
Time at Overhead (HH:MM:SS.SSS) [T _{OH}]			
Y Offset at Overhead (Feet) [Y _{OH}]			
Aircraft Height at Overhead (Feet AGL) [Z _{OH}]			
Climb/Descent Angle (Degrees) [γ]			
Horizontal Cross-Track Angle (Degrees) [χ]			
Ground Speed (FPS) [V _G]			
Reference Height (Feet AGL) [Z _{OHR}]			
Ref. Climb/Descent Angle (Degrees) [γ_{REF}]			
Ref. Groundspeed (FPS) [V _{GR}]			
Reference Microphone Coordinates (Feet)	X [X _{MICR}]		
	Y [Y _{MICR}]		
	Z [Z _{MICR}]		
Ref Microphone Height (Feet AGL)	[H _{MICR}]		
Test Day Sound Speed (FPS) [c]			
Test Day Sound Speed Temperature (°F)			



U.S. Department
of Transportation
**Volpe National
Transportation
Systems Center**

Applicant Software & Methodology Validation Data Submittal

For fixed-wing aircraft data.

Form 3

PROCESSING RESULTS - TEST-DAY "ADJUSTED AS-MEASURED"

APPLICANT _____

TEST DATE (MM/DD/YY) _____

AIRCRAFT DESIGNATION _____

Event ID			
Site ID			
Number of Raw Data Records			
Time @ Start of First Raw Data Record (HH:MM:SS.SS)*			
Time @ PNLTM (HH:MM:SS.SS)			
PNLTM Record Number [k_M]			
First 10dB-down Record Number [k_F]			
Last 10dB-down Record Number [k_L]			
EPNL (dB)			
PNLTM (dB)			
PNLM (dB)			
L _{ASmax} (dB)			
Tone Correction Band @ PNLTM			
Test-Day Bandsharing Adjustment (dB) [Δ_B]			
Number of Records within 2 dB of PNLTM			
Record Numbers of Peaks within 2dB of PNLTM			
Test-Day Sound Propagation Distance (Slant Range) @ PNLTM (Feet) [$SR(k_M)$]			
Test-Day Closest Point of Approach / Minimum Distance (Feet) [CPA]			

*See timing illustration



U.S. Department
of Transportation
**Volpe National
Transportation
Systems Center**

Applicant Software & Methodology Validation Data Submittal

For fixed-wing aircraft data.

Form 4a

PROCESSING RESULTS - REFERENCE CONDITIONS SIMPLIFIED PROCEDURE

APPLICANT _____

TEST DATE (MM/DD/YY) _____

AIRCRAFT DESIGNATION _____

Event ID			
Site ID			
EPNL _R (dB)			
PNLTM _R (dB)			
Tone Correction @ PNLTM _R			
Tone Correction Band @ PNLTM _R			
Reference Sound Propagation Distance (Slant Range) @ PNLTM _R (Feet) [SR(<i>k_M</i>)]			
Sound Emission Angle @ PNLTM _R (Degrees) [θ(<i>k_M</i>)]			
Sound Elevation Angle @ PNLTM _R (Degrees) [β(<i>k_M</i>)]			
Test-Day X Emission Coordinate @ PNLTM _R (Feet) [X _E (<i>k_M</i>)]			
Test-Day Y Emission Coordinate @ PNLTM _R (Feet) [Y _E (<i>k_M</i>)]			
Test-Day Z Emission Coordinate @ PNLTM _R (Feet) [Z _E (<i>k_M</i>)]			
Simplified Delta 1 (Spherical spreading and absorption effects on PNLTM spectrum) (dB) [Δ ₁]			
Simplified Delta 2 (Duration effects) (dB) [Δ ₂]			
Simplified Delta 2D (Distance component of Delta 2) (dB) [Δ _{2D}]			
Simplified Delta 2S (Speed component of Delta 2) (dB) [Δ _{2S}]			
Simplified Delta Peak (Adjustment for secondary peaks) [Δ _{Peak}]			
Simplified Delta Bandshare (Adjustment for Bandsharing effects on Test-Day PNLTM spectrum) [Δ _B]			



U.S. Department
of Transportation
**Volpe National
Transportation
Systems Center**

Applicant Software & Methodology Validation Data Submittal

For fixed-wing aircraft data.

Form 4b

PROCESSING RESULTS - REFERENCE CONDITIONS INTEGRATED PROCEDURE

APPLICANT _____

TEST DATE (MM/DD/YY) _____

AIRCRAFT DESIGNATION _____

Event ID			
Site ID			
EPNL _R (dB)			
PNLTM _R (dB)			
Time @ PNLTM _R (HH:MM:SS.SS)*			
PNLTM _R Record Number [k_{MR}]			
Reference First 10dB-down Record Number [k_{FR}]			
Reference Last 10dB-down Record Number [k_{LR}]			
Tone Correction @ PNLTM _R (dB)			
Tone Correction Band @ PNLTM _R			
Test-Day Sound Propagation Distance (Slant Range) @ PNLTM _R (Feet) [$SR(k_{MR})$]			
Reference-Day Sound Propagation Distance (Slant Range) @ PNLTM _R (Feet) [$SR_R(k_{MR})$]			
Sound Emission Angle @ Reference PNLTM _R (Feet) [$\theta(k_{MR})$]			
Test-Day X Emission Coordinate @ PNLTM _R (Feet) [$X_e(k_{MR})$]			
Test-Day Y Emission Coordinate @ PNLTM _R (Feet) [$Y_e(k_{MR})$]			
Test-Day Z Emission Coordinate @ PNLTM _R (Feet) [$Z_e(k_{MR})$]			
Integrated Reference Condition Bandsharing Adjustment (dB) [Δ_{BR}]			
Reference Condition Closest Point of Approach (Feet) [CPA_R]			



U.S. Department
of Transportation
**Volpe National
Transportation
Systems Center**

Applicant Software & Methodology Validation Data Submittal

For fixed-wing aircraft data.

Form 5-1

SUBMITTAL CHECKLIST (Page 1 of 2)

1. Complete **Form 1**
2. Supply Flow Diagram and/or description of measurement, analysis & adjustment systems.
Data Submittal Instructions Item 1
3. Supply 1/3 Octave Uncorrected Aircraft Noise Spectral Time History
Data Submittal Instructions Item 2
4. Supply 1/3 Octave Pre-Detection Background Noise Spectrum
Data Submittal Instructions Item 3
5. Supply 1/3 Octave Post-Detection Background Noise Spectrum
Data Submittal Instructions Item 4
6. Supply Meteorological Data
Data Submittal Instructions Item 5
7. Supply Aircraft Position Data
Data Submittal Instructions Item 6
8. Complete **Form 2**
9. Supply 1/3 Octave Frequency-Dependent System Response Correction Spectrum
Data Submittal Instructions Item 7.a
10. Supply 1/3 Octave Microphone Sensitivity Correction Spectrum
Data Submittal Instructions Item 7.b
11. Supply data and description of any other adjustments applied to obtain Test-Day
"adjusted as-measured data, including procedures to correct for background noise effects."
Data Submittal Instructions Items 7 - 11
12. Supply 1/3 Octave Test-day "adjusted as-measured" Aircraft Noise Spectral Time-History
Data Submittal Instructions Item 12
13. Complete **Form 3**
14. Supply description of computer processing characteristics and methodology used to adjust data to
Reference-day conditions, including reference parameters.
Data Submittal Instructions Item 13



U.S. Department
of Transportation
**Volpe National
Transportation
Systems Center**

Applicant Software & Methodology Validation Data Submittal

For fixed-wing aircraft data.

Form 5-2

SUBMITTAL CHECKLIST (Page 2 of 2)

15. Supply 1/3 Octave Reference Condition Aircraft Noise Spectral Time History:
 - Entire event, if using "Integrated" procedure
 - PNLTM record (and records for peaks within 2dB of PNLTM if applicable), if using "Simplified" procedureData Submittal Instructions Items 14.1.g/14.2.d

16. Supply Aircraft Noise Geometry Data:
 - Entire event, if using "Integrated" procedure
 - PNLTM point (and records for peaks within 2dB of PNLTM if applicable), if using "Simplified" procedureData Submittal Instructions Items 14.1.g/14.2.e

17. Complete **Form 4a** and/or **4b**

17. Complete **Att. 2 - Software Validation Dataset Identification**



U.S. Department of Transportation
Volpe National Transportation Systems Center

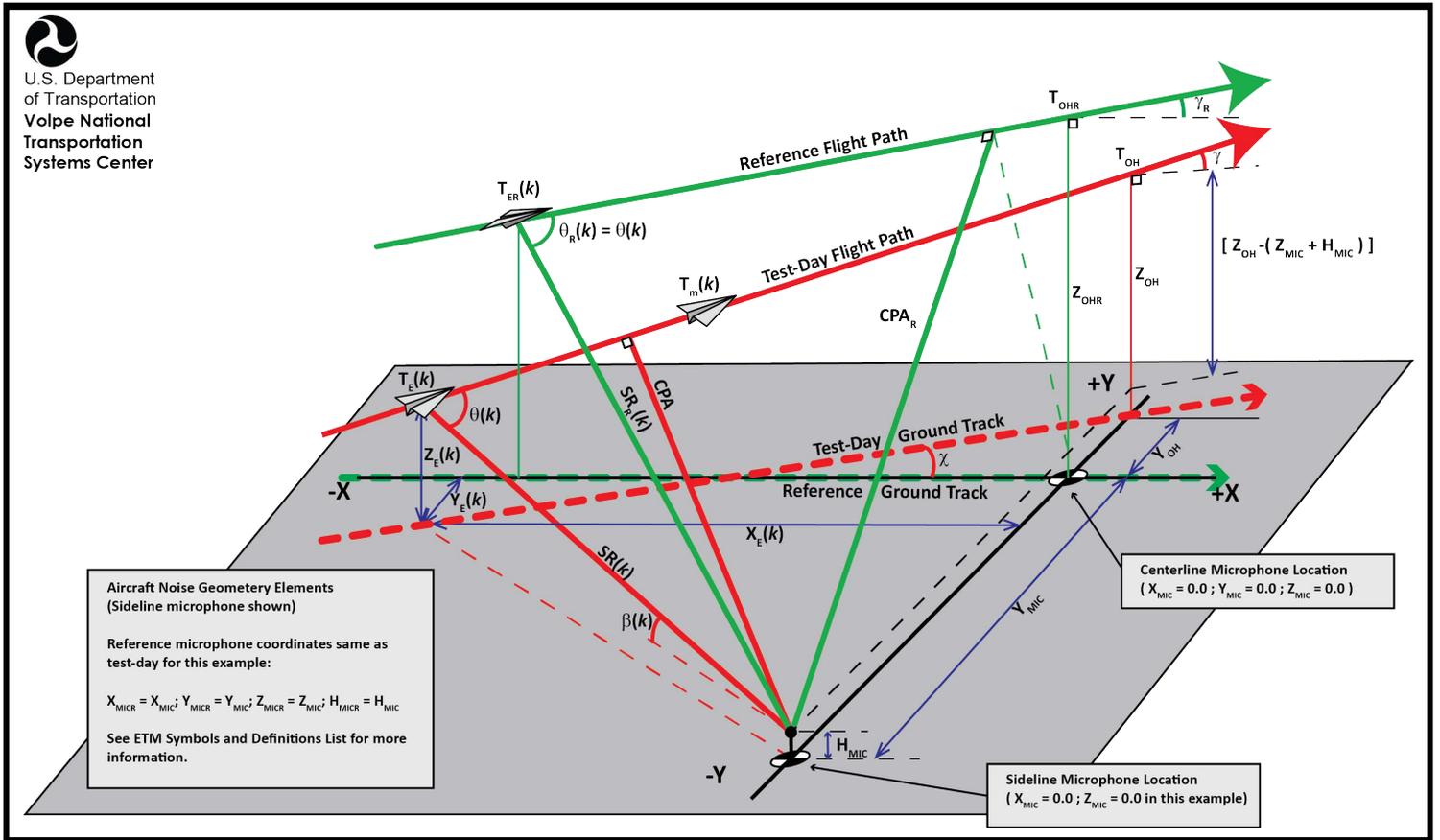


Figure 1 - Illustration of Noise Geometry for Test-Day and Reference Flight Tracks

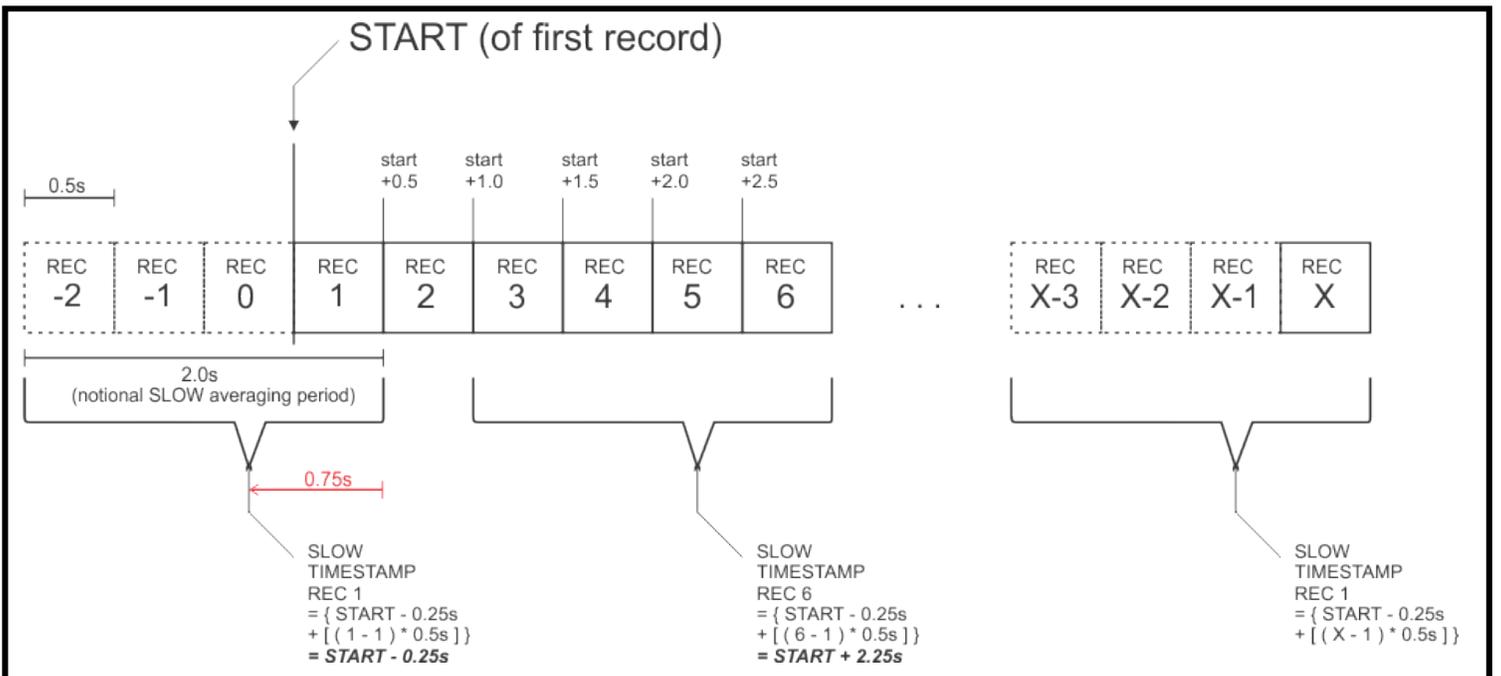


Figure 2 - Illustration of Start Times and Timestamps for Slow-Averaged Records

List of Volpe Resources for Aircraft Noise Certification

Software & Methodology Validations

A variety of information and resource materials is available to applicants to address common issues identified during the validation process. These materials were developed by Volpe - or with substantial input from Volpe - and have been made available previously via presentations at FAA's Recurrent Acoustic DER Seminars, or directly to an applicant from Volpe during validation. Some of the content has since been formalized in official specifications and guidance materials by means of part 36, Advisory Circular AC36-4, Annex 16, Vol. I, and the Environmental Technical Manual, Vol. I. Some of these materials may provide additional detail or further insight into existing specifications and guidance materials.

Additional materials will be developed as necessary, and will be provided to applicants as they become available. The following is a list of currently-available materials which will be posted on Volpe's Aircraft Certification Validation webpage, and may be obtained on request by emailing David.Read@DOT.Gov or Christopher.Cutler@DOT.Gov.

1. **Symbols & Definitions list** – excerpted from CAEP/10 Steering Group Approved version of Environmental Technical Manual, Vol. I. This list is comprehensive and up-to-date. It was developed via Authority and Industry participation in ICAO Working Group 1, and includes agreed-upon definitions and symbols. It is available in the version of the ETM that has not yet been formally published, but was approved by Steering Group during CAEP/10. (The entire ETM - from which this list has been excerpted - is available to the noise certification community on the ICAO Working Group 1 website. Contact your WG1 representative for access.);
2. **Illustrations of aircraft noise geometry elements** (Fig. 1 contained in this package) and of **start time vs. slow “timestamps”** (Fig. 2 contained in this package). Separate files for each of these fundamental illustrations are available;
3. **Illustration of background noise bands** – Annex 16 band numbering vs. ANSI/ISO band numbering; Characterization as “low-frequency” and “high-frequency” bands; Bands eligible for frequency-extrapolation; Bands eligible for time-extrapolation, etc. (This illustration has not previously been widely distributed.);
4. 2003 DER Seminar Presentation on **background noise adjustment process flow** (Step-by-step walkthrough and flow diagrams for test-day background noise process developed for the Advisory Circular and ETM);

5. 2014 DER Seminar Presentation on **background noise characterization** (Clearly defines the elements of background noise as used in the method developed for the Advisory Circular and ETM, and discusses methods for determination of the various elements.);
6. **Wind Speed Limits & Information** slides from 2010 DER Seminar Presentation (Discussion and identification of the updated and improved specifications developed in Working Group 1 for Annex 16, Vol. I);
7. Slide on **Atmospheric Layering** (apportioning of α s) from 2005 DER Seminar Presentation;
8. 2014 DER Seminar Presentation on **atmospheric absorption using the methods of SAE ARP 5534** (Identifies some of the issues that will need to be addressed prior to the imminent inclusion of this methodology in aircraft noise certification.);
9. Slides on **10 dB-down point selection** from 2005 DER Seminar Presentation (Discussion and illustrations of determining start and end points of the EPNL noise duration);
10. Slide on **noise duration** from 2012 DER Seminar Presentation (A slide illustrating a typical noise duration, with current symbols and information);
11. Slide on **varying reference spectra durations** from 2005 DER Seminar Presentation (illustrates why reference-condition spectra typically vary in effective duration from the test-day half-second records);
12. Volpe “DARP” (Digital Audio Recorder Protocol) – **guidance on validation of recording instrumentation** (Detailed guidance for evaluation of digital audio recording instrumentation for US applicants.);