Angelo J. Campanella

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High intensity air ultrasound source for determining ultrasound microphone sensitivity up to 400 kHz

By **Angelo J. Campanella**

J. Acoust. Soc. Am. **132** , 1921 (2012) ; **http://dx.doi.org/10.1121/1.4755050**

A broadband air jet ultrasound source RSS101U-H for animal bioacoustics research produces broadband ultrasound to at least 400 kHz. Free field reciprocity calibration of ½" condensermicrophones on-axis grid caps removed using sine wave excitation by the method of Rudnick and Stein [JASA 20 pp 818-825 (1948)] was made (previously used to 280 kHz [JASA 67 p 7 (1980)]). Measurement from 5 kHz to 100 kHz was made in 1 kHz bins via an FFT analyzer. A communications receiver was used from 40 kHz to 400 kHz. The sensitivity of a ¼" microphone was determined from the free field of the reciprocity ½" microphone source. Air jet ultrasound level at 80 mm distance was then determined with the ¼" microphone. Communications receiver 2.5 kHz bandwidth data was reduced to 1 kHz bin values. Air humidity sound absorption was determined via ANSI 1.26. The ¼" microphone sensitivity and broadband source sound level results in 1 kHz bands to 400 kHz are presented. Air jet spectral level was 97 dB re 20 uPa @ 75 kHz to 57 dB @ 400 kHz. This can be used to rapidly determine the sensitivity of any air ultrasoundmicrophone over this frequency range.

A method for free-field transfer calibration of electret microphones at ultrasound frequencies in air using a stable broad band ultrasound source.

By **Angelo J. Campanella**

J. Acoust. Soc. Am. **127** , 2010 (2010) ; **http://dx.doi.org/10.1121/1.3385222**

A rotating turbulence screen wheel sound source now in use in the air ultrasound instrument industry for product quality control provides a steady source of broad band ultrasound. This source is broad band through at least 100 kHz. It is calibrated as a secondary standard using a one-quarter inch condensermicrophone grid removed normal incidence and corrected for free-field conditions per the microphone manufacturer free-field response. Sound pressure amplitude is measured at a distance of 500 mm and from 1 to 100 kHz in 1-kHz FFT bins. Calibration site sound absorption by humid air is calculated to correct the emitted sound pressure values to be reinserted for the user test site air temperature and humidity. Transfer calibrations of two electretcondensermicrophones are shown. Microphone phase response measurement methods will also be investigated and discussed.

Outdoor sound power calibration of reference sound sources.

By **Angelo J. Campanella**

J. Acoust. Soc. Am. **128** , 2481 (2010) ; **http://dx.doi.org/10.1121/1.3508904**

Methods and procedures for outdoor sound power measurement for reference sound sources according to ISO 6926/ANSI 12.5 are discussed. This method assures no low-frequency cutoff of the sound power determination. A quiet outdoor site with a sealed surface of suitable radius clear of structures and trees is required. Measurement plan-positions are marked on the surface. Equipment components are prepared in advance for efficient deployment. Weather forecasts are used to determine day or night measurement periods that are free of rain and wind. When ready site barometric pressure dry bulb temperature and wet bulb temperature are measured. The microphone height and the 2 m radius are positioned with a fixture. Sound pressure level data are acquired at all microphone positions serially if necessary. Sound power results are corrected to standard conditions. High-frequency results are corrected for humidity as it affects sound absorption by air. Results obtained over several years and at a variety of temperatures are discussed.

Flyover noise reduction for general aviation aircraft

By **Angelo J. Campanella**

J. Acoust. Soc. Am. **60** , S122 (1976) ; **http://dx.doi.org/10.1121/1.2003160**

A survey of noise emission reduction techniques is presented for propeller driven aircraft. Most of the audible noise is

generated by the propeller tip traveling with a local velocity near that of the speed of sound. The feasibility of mechanical design steps (larger geared propeller and longer landing gear) required to reduce this speed was investigated. It was found that only new aircraft designs can be so configured. Existing aircraft will continue to operate. The attrition rate of these existing aircraft (1%–3% per year) is small so that certain operational methods are desirable to achieve quieter airport environs. Procedures of administrative control operational rules a noise abatement power adjustments are described which decrease the noise exposure experienced on the ground. Enlightened land planning by county and state officials is described. [Work supported by FAA.]

Rural community noise caused by 345/138 kV substation transformer

By **Angelo J. Campanella**

J. Acoust. Soc. Am. **69** , S30 (1981) ; **http://dx.doi.org/10.1121/1.386319**

Residents 360 m (1200 ft) from a large (6 × 8 × 4.5 m high) 345/138 kV transformer installed in a new power substation in a rural setting complained of its noise emission especially at night. Octave band and 24-h A-weighted noise measurements were made. The 120-Hz sound level was found to be 90 to 105 dB at the transformer surface. Transformer noise emission did not vary significantly with transformer loading or time of day. The distant (360 m) noise level was from 40 to 47 dBA (*N*-30 to *N*-45) depending on intervening terrain and time of day. In calm summer air the annoying sound was found to be in the 125-Hz band at the residence beyond a vegitated rise and 250 to 500 Hz for a residence with line-of-sight contact over a shallow depression. The line-of-sight resident's complaint that the noise was greatest at night was corroborated by the 24-h measurement. That noise level was found to be typically 38 dBA from 11 a.m. to 7 p.m. and 45 dBA from 9 p.m. to 6 a.m. It is postulated that the depression accumulated cool air at night thus refracting the sound onto that site. Recommendations for a noise barrier wall was made to the power company operator.

Field testing of wood joist floor/ceiling assemblies and comparison with laboratory test results

By **Angelo J. Campanella**

J. Acoust. Soc. Am. **73** , S100 (1983) ; **http://dx.doi.org/10.1121/1.2020199**

New construction of multifamily living units often includes noise insulation performance testing. The degree and source of deviation of field test (FSTC and FIIC) values from those of the prototype laboratory specimen are generally not predictable. Field testing according to ASTME336-77 (FSTC) and ISO140 VII-78 (FIIC) were performed. In this test series flanking and the site background noise was controlled and octave-band data was used to reduce test time [A. J. Campanella J. Acoust. Soc. Am. Suppl. I **69** S8 (1981)]. Testing was conducted in partially completed units including wood framing windows doors wiring limited HVAC ducting. Wall FSTC tests generally agreed with laboratory tests but the wood floors of rooms of reduced dimensions exhibited serious FSTC and impactsound level deficiencies amounting to as much as 10 to 14 dB in the 125-Hz octave band. Additional 63-Hz octave-band data indicated that the floor/ceiling structures exhibited low TL values in either the 63- or 125-Hz octave bands. This phenomenon was linked to bar-like resonance in short joist lengths (8 to 10 ft vs 14 ft in the lab test). Accelerometer measurements on exposed joists showed significant joist vibration in the free-end mode for the 125-Hz band under impact excitation. A layer of gypsum board was added to the subfloor sandwich to effect mass loading and added damping of the free-bar joist vibrational mode so that the 125-Hz FTL was greater than that of the 63-Hz octave band. Acceptable FSTC values were achieved by in addition placing the ceiling gypsum board on separate 2×4 subjoists with an added layer of R-11 insulation.

Cabin noise mathematical modeling for single engine aircraft

By **Angelo J. Campanella**

J. Acoust. Soc. Am. **73** , S21 (1983) ; **http://dx.doi.org/10.1121/1.2020279**

Previous in-flight data [A. J. Campanella J. Acoust. Soc. Am. Suppl. 1 **69** S28 (1981)] indicated that the main source of cabin noise in single-engine aircraft often 88 to 93 dBA at the pilot's ear position during cruise flight arises from the engine exhaust with the propeller noise apparent only during takeoff and full power climb. Mathematical modeling of the exhaust and propeller noise propagation from their source to the pilot's ear position was devised to optimize exhaust silencing means within the constraints presented by aerospace structures. Through comparison with in-flight data it was found that the matching assumption should include that fact that the exhaust SPL harmonics have a velocity maximum at the exhaust outlet and a pressure maximum at the piston/cylinder source. It was further assumed that all harmonics had the same amplitude representing an impulse source. Exhaust gas temperature transport velocity density outside air temperature cabin

temperature flight altitude floor and window barrier (mass law) and intervening distances were included as model variables. Propeller noise was modeled after P. A. Franken and L. L. Beranek [*Noise Reduction* edited by L. L. Beranek (Krieger Huntington NY 1980) pp. 685–688]. This computerized mathematical model can be used to predict the effect of exhaust outle location and a variety of exhaust silencer components on the A-weighted sound level at the pilot's ear position.

Tinnitus occurence and modification—A case study

By **Angelo J. Campanella**

J. Acoust. Soc. Am. **75** , S31 (1984) ; **http://dx.doi.org/10.1121/1.2021377**

In July 1982 a brief exposure to 133-dB 400-Hz sounds to the author caused a mild case of tinnitus to erupt that evening. Ancillary circumstances included insufficient earplug attenuation fatigue and hot weather. No significant TTS was noted at the time of exposure though the environmental noise was sufficient to mask mild TTS. Tinnitus tones were generally above 4 kHz and occasionally of narrowband (versus tonal) quality at an SPL estimated to be about 35 dBA. Audiograms taken a few days after the exposure indicated no notable PTS though personal experience indicated a slight loss of response in the 4- 5- or 6-kHz region. Lack of sleep was relieved by medication and tinnitus masking for a few weeks. Long-term acclimatization is now more or less complete. Recent measurements indicate that permanent tinnitus tones lie in the 10 to 13 kHz region. Mild exposure to noise (vis a 60-mile automobile trip without earplugs) incites lower tones in the 5- to 8-kHz region which persist fo a few hours. Mechanical pressure on certain skull locations will increase the 10/13-kHz tinnitus tone level by 10 to 20 dB. Still another pressure point will stop the tone as long as the pressure is applied. Blood pressure pulses individually modulate the 10/13-kHz tinnitus by an estimated 10 dB. Acoustical measurements pertinent to these observations will be presented. Such observations suggest that tinnitus can be altered by such mechanisms as pressure stresses or dislocations in the cochlear region. It is also possible that the damage mechanism (in this case) would include mechanical stress induced in the cochlear assembly and its attachments by intense sound vibrations.

Night air cargo operations flyover noise mitigation by a municipality

By **Angelo J. Campanella**

J. Acoust. Soc. Am. **77** , S2 (1985) ; **http://dx.doi.org/10.1121/1.2022273**

A 1981 Air Force Draft Environmental ImpactAnalysis (DEIA) on converting Rickenbacker Air National Guard Base (RANGB formerly Lockbourne Air Force Base) to a civilian air terminal operated by a new county port authority (RPA) indicated that the DNL increase would be insignificant. In 1982 residents of the central Ohio village of Groveport (1.7 miles from the landing threshold of RANGB Runway 22) showed in federal court that military air activity was not as noisy as modeled in the DEIA ceased after 11:00 pm and did not resume until 8:00 or 9.00 am the next day. Noise monitoring near Dayton's Municipal Airport where Emery Air Freight operates found five hourly L_{eq}'s which ranged from 63 to 73 dBA and peaks from 74 to 94 dBA. For the same times Groveport hourly L_{eq}'s were about 45 dBA with 50- to 65-dBA peaks. The proposed civilian air cargo carrier projected 26 round trips per night by heavy aircraft such as the DC-8 and the Boeing 727. Their night noises would be disruptive to sleep since not all houses had adequate noise insulation and aircraft noise abatement procedures could not be adequate. The court ruled that the Air Force EIA DNL values be made more accurate and RPA should promulgate a noise mitigation plan for Groveport's approval. Beyond feasible aircraft noise abatement procedures the plan is that within the 90 SEL contour of the noisiest tenant aircraft and where night overflight noises in sleeping quarters exceed 55 dBA residences shall be insulated or purchased by the RPA. Outside the 90 SEL contour only houses where the interior noise peak exceeds 55 dBA an arbitrated number of times per night are included. Civilian air cargo operations have not started.

Criteria and analysis for fan/floor vibration isolation in elevated mechanical rooms

By **Angelo J. Campanella**

J. Acoust. Soc. Am. **81** , S31 (1987) ; **http://dx.doi.org/10.1121/1.2024188**

In selecting isolators for fans and other mechanical equipment mounted on elevated mechanical room floors it is necessary tc know the degree with which their vibrations will affect the occupants of the floor on which it is mounted as well as the floor below. A computational procedure was developed based on a two degree of freedom model representing the resulting floor motion for known masses resonances and damping of the floor and fan mount. A computational criterion was developed for vibration input and human vibration tolerance based on values commonly found in the literature. A FORTRAN program featuring interrogatory input prompts and a screen graphics output of the floor vibrational velocity over the frequency band of concern executes in about 30 s. With this tool one can immediately judge the effectiveness of various fan masses and spring

constants. Two case studies are discussed.

Preliminary values of clarity and intelligibility for small auditoria, meeting, and teleconference rooms

By **Angelo J. Campanella**

J. Acoust. Soc. Am. **97** , 3337 (1995) ; **http://dx.doi.org/10.1121/1.413017**

Clarity (C80) and intelligibility (D50) normally measured for large auditoria provide an alternative to reverberation time (RT60) to evaluate the acoustical performance of many critical smaller rooms. A Larson Davis 2900 real time analyzer and sound leve meter was used to record a rapid sequence of octave band spectra from impulsive sound. A PC program was written to extrac this data from the LD2900 and process it into C80 D50 and TCT values. Experimental values were obtained in ten different rooms including auditorium church theater lab chapel gym music rehearsal teleconference and living rooms. Room qualities varied from good through those in need of correction for the intended room use. Measured quantities were compared with opinions on existing room performance to provide preliminary desirable ranges of C80 D50 and TCT according to room use.

Precision of reference sound source hemianechoic sound power calibration using a fixed microphone array: Relation to ISO 6926 revision

By **Angelo J. Campanella**

J. Acoust. Soc. Am. **97** , 3252 (1995) ; **http://dx.doi.org/10.1121/1.411659**

Reference sound source calibration by the hemianechoic ISO 3745 method allowed a course array of 10 measurementmicrophone positions on a hemisphere. Draft revision of ISO 6296 provides for a difficult meridional arc constan vertical velocity microphone scan. An improved array of multiple fixed microphone positions is proposed as an alternate to the meridional scan method. Bias of the improved array was simulated with Mathcad 4.0. Agreement was predicted to be within 0.2 dB up to 4 kHz for 10 points and up to 8 kHz for 20 points. Experimental results for three microphone position arrays were compared to reverberation room results over the limited frequency range of 125 to 8000 Hz. The standard deviation of the difference was 0.84 to 0.89 dB (0.81 dB predicted) for the old ISO 3745 array. For an array having 10 fixed height difference positions from 0.15*R* to 0.95*R* the standard deviation was 0.62 dB (0.61 dB predicted). For 20 fixed heights from 0.025*R* through 0.975*R* the standard deviation was found to be 0.63 (0.18 predicted). Calculated results and experimental test results compared with reverberation room results will be presented.

Generation and Detection of Acoustic Waves by Means of the Hall Effect in Electrolytes

By **Angelo J. Campanella**

J. Acoust. Soc. Am. **27** , 1005 (1955) ; **http://dx.doi.org/10.1121/1.1917991**

Alternating currents at frequencies up to 1 mcps were passed through a concentrated KCl solution in the presence of a magnetic field normal to the current. Interaction with the magnetic field caused both positive and negative ions to move in the same direction normal to the field and current. The alternating force of the ions on the liquid produced an acoustic pressure i the third normal direction. This wave was propagated through a delay tube and detected. The reciprocal effect wherein the cell was used as a receiver was also investigated. Although the sensitivities are small they are calculable for plane waves with simple theory. The receiver is a purely velocity-sensitive microphone.

Interior and exterior diesel locomotive noise measurements

By **Angelo J. Campanella**

J. Acoust. Soc. Am. **60** , S23 (1976) ; **http://dx.doi.org/10.1121/1.2003231**

Diesel locomotive noise data accumulated over the past two years for hearing-damage assessment and land-use analysis are presented. Interior locomotive noise levels of the cab and engine areas were measured while the engine was developing all power levels was measured. Cab noise levels varied from 88 to 91 dB*A* at full power depending on engine type when the windows and doors were closed. Engine areas noise was found to be between 104 and 124 dB*A* at full power depending on engine enclosure design. Extenal noise emissions were measured along an active east-west pair of tracks to determine land use classification for residences. This site typified enroute noise emission on flat agricultural terrain. Numerous observations were plotted versus distance from the tracks to derive an enroute emission model. Land use disposition was determined for future residences.

Aircraft cabin noise barrier design and test

By **Angelo J. Campanella**

J. Acoust. Soc. Am. **60** , S123 (1976) ; **http://dx.doi.org/10.1121/1.2003161**

The cockpit and cabin of contemporary propeller driven lightplanes continue to suffer high ambient noise levels in flight. These noise levels are typically 85–95 dB*A*. It was sought to typify and test lightweight barrier configurations in an attempt to achieve the 30 dB predicted performance [J. T. Howlett and D. A. Morales J. Acoust. Soc. Am. **59** S64 (A) (1976)]. Several structural arrangements were tested as 12 in. (30 cm) square samples. Broadband transmission loss values of 20–25 dB were easily achieved as opposed to considerably smaller values for thin aluminum panels. The barrier performance due to stiffness over and above that due to the mass law is clearly evident at lower frequencies. The achievable TL values are compared with known aircraft noise spectra both inside the outside the cabin to predict cabin quieting achievable with practical weight and cost constraints.

Community noise ordinance drafting by a city *ad-hoc* noise committee

Angelo J. Campanella and **P. Gary Brown**

J. Acoust. Soc. Am. **66** , S31 (1979) ; **http://dx.doi.org/10.1121/1.2017715**

Through motivation by a city councilman Charles Petree an *ad-hoc* committee was formed to review existing city noise-related codes. Representation included city council staff the health zoning and police departments an acoustical consultant the industrial commission and building association the society of professional engineers the electric company and a private citizen. This body met many times over one year to review codes and ordinances. Recommendations included consolidating all noise related codes and ordinances into one addendum to the City Code. Additions against squealing tires limits on motorboat noise and the replacement of octave-band limits for manufacturing districts with L_{eq} limits along common residential/institutional/commercial/manufacturing property lines were made. The police department concluded that the existing muffler ordinance requiring “a muffler in good working condition with baffle plates …” was satisfactory for enforcement. These recommendations—to be detailed in the presentation—are being submitted to the City Council for action Airport noise as it affects land use and zoning actions will be treated during calender year 1980.

Multifamily party wall noise insulation by single metal and wood stud walls

By **Angelo J. Campanella**

J. Acoust. Soc. Am. **69** , S8 (1981) ; **http://dx.doi.org/10.1121/1.386015**

Residents of apartments with a single-steel stud party wall were satisfied with its noise insulation. The residents of apartment with a single wood stud wall were displeased to the extent that the owner is being forced to improve the wall's noise insulation. The field sound transmission loss (FTL) of the steel stud wall and the wood stud partition wall between apartment units was measured. The equivalent STC values for these two walls were calculated from these data. The wood stud wall was found to have an equivalent STC 37 value and the steel stud wall an equivalent STC 48 value. These STC values were found to be in basic agreement with those obtained by laboratory tests on similar walls. It was concluded that for single stud walls wood studs are an inferior sound insulator as compared to steel studs. The reason for this is believed to be that the steel studs act as their own resilient clips. This makes the steel stud structure much more cost effective than wood stud construction for single stud walls. It was recommended to the owner that he construct an additional stud wall set apart from the existing wood stud wall to achieve acceptable noise insulation.

Some calibrations and applications of the aerodynamic fan reference sound source

By **Angelo J. Campanella**

J. Acoust. Soc. Am. **86** , S21 (1989) ; **http://dx.doi.org/10.1121/1.2027416**

Introduced by H. C. Hardy [Noise Control (May 1959)] the mechanical reference sound source (RSS) provides a broadband sound field by turbulent air shear at the perimeter of a rotating open centrifugal fan wheel. For a given wheel rpm geometry and air density the emitted sound level is constant within less than 1 dB when averaged over a few seconds. The sound power is relatively uniform in octave or third-octave bands from 125 to 8000 Hz. Usable levels of sound power are emitted above and below these frequencies with field measurements in the 63-Hz octave band feasible in large rooms. Small motor-driven units have endured for decades. Hemi-anechoic reverberation room and intensity methods JR. Peppin *et al.* NOISE-CON 88 and W. D. Gallagher (private communication)] for RSS calibration will be described. Low-frequency discrepancies between free-field and reverberation roomcalibration methods [P. Brnel B & K Review (1978 No. 3)] have diminished as the reverberation room method is improved (better sound diffusion space averaging and decay analysis) [P. K. Baade 1989 ASHRAE Trans. (January 1989)]. The portability and reliability of this device suit it especially to worldwide use in

hostile environments such as factory assembly rooms and construction sites. Some recent experiences in application of the Acculab RSS to small and large device sound powermeasurement and room sound absorption will be described.

Development of Standard Guide ASTM E966, "Field measurement of facade sound isolation"

By **Angelo J. Campanella**

J. Acoust. Soc. Am. **88** , S135 (1990) ; **http://dx.doi.org/10.1121/1.2028607**

Standard Guide ASTM E 966-84 (similar to ISO 140/5) describes *in situ* field methods of measuring the ability of windows and doors to prevent the penetration of environmental noise into a room. Recent ASTM review for reapproval resulted in more explicit method options and descriptions. Six different ways are now available where noise reduction and sound transmission loss can be measured each distinguished by the way that the external sound field is created and measured. The user determines which of these techniques is best suited to his or her field situation. *In situ*sound fields are unidirectional (single loudspeaker or point source) or quasidiffuse (traffic or flying aircraft) whereas that in the two-room laboratory methods is diffuse. Three options for measuring the incident sound level are: flush around 2-m distance (as in ISO 140/V-3.1 using traffic and remote free-field at an equivalent distance (as in ISO 140/V-4.1 using a loudspeaker).Sound transmission loss values are adjusted for comparison with E 90 or ISO 140/III laboratory results. Point source adjustment is according to the cosine of the angle of incidence. Line source adjustment is by the "average cosine" [P. T. Lewis J. Sound Vib. **33** Pt. 3 127–141 (1974)] but *x*- *y*- and *z*-site dimensions are converted to elevation angle and included azimuthal angle of the traffic line as seen from the test facade. The six methods are compared with other FHWA and FAA methods in common use.

The effect of coincidence transmission on field measurement of facade sound isolation

By **Angelo J. Campanella**

J. Acoust. Soc. Am. **89** , 1921 (1991) ; **http://dx.doi.org/10.1121/1.2029516**

Windows walls and doors suffer coincidence transmission (CT). Sound penetration increases with incidence angle to a maximum near grazing incidence. Construction material "standard" sound isolation is cataloged from laboratory (ASTM E 90 or ISO 140/III) diffuse incident sound transmission loss (TL) tests. Field facademeasurements per ASTM E 966 [J. Acoust. Soc. Am. Suppl. 1 **88** S135 (1990)] apply 10 log(cos θ) angle correction (proper for open apertures e.g. ventilators) to compute inside-outside transmission loss (OITL) which is comparable with diffuse TL values. For panels with CT comparable values using unidirectional (loudspeaker)sound require 45- to 60-deg incidence or "field transmission loss" adjustment CT panel transmissivity derived by Cremer Beranek Ver and Holmer indicates inverse cosine-squared behavior and a transparency ("coincidence") frequency for each angle. This can be integrated over all diffuse angles for comparison to TL values [e.g. R. E. Jones J. Acoust. Soc. Am. **66** 148–164 (1979); TL = 26–28 dB at 500 Hz for 16-mm (5/8-in.) drywall]. Comparison indicates integration to 78 or 80 deg. Theory/OITL/TL agreement ("match") occurs for unidirectional sound incident at around 60 deg. Theory/TL or OITL/TL data by others for a drywall stud wall block wall and a window showed "match" angles from 45 to 60 deg. More CT test data on thin panels and three-way comparisons (theory/OITL/TL) are needed to improve OITL precision and reduce bias while expanding the range of test angles and source types (e.g. traffic).
