



AEROSPACE RECOMMENDED PRACTICE

ARP1307™

REV. C

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Superseding ARP1307B

(R) Measurement of Exterior Noise Produced by Aircraft Auxiliary Power Units (APUs)
and Associated Aircraft Systems During Ground Operation

RATIONALE

This document was updated to align nomenclature with what is used in aircraft noise certification standards and to recommend presentation of data using one of two upper frequency limits.

INTRODUCTION

Many commercial, business, and military transport aircraft are equipped with one or more on-board auxiliary power units (APUs) to provide self-contained power for operating essential aircraft systems during typical servicing of aircraft and during passenger boarding operations. Increased awareness of noise produced during these operations of APUs and associated ground operated equipment such as environmental control systems (ECS), electrical generators, blowers, fuel pumps, hydraulic pumps and cooling fans has created a need for a common basis whereby noise information can be communicated among airport authorities, airline operators, and aircraft equipment manufacturers. Identification of all contributing noise sources is required to properly interpret the measured data. Standard procedures for noise measurement, analysis and reporting will help fulfill this need.

1. SCOPE

Test procedures are described for measuring noise at specific receiver locations (passenger and cargo doors, and servicing positions) and for conducting general noise surveys around aircraft. Procedures are also described for measuring noise level at source locations to facilitate the understanding and interpretation of the data.

Requirements are identified with respect to instrumentation; acoustic and atmospheric environment; data acquisition, reduction and presentation, and such other information as is needed for reporting the results.

This document makes no provision for predicting APU or component noise from basic engine characteristics or design parameters, nor for measuring noise of more than one aircraft operating at the same time.

No attempt is made to suggest acceptable levels of noise or suitable subjective criteria for judging acceptability. ICAO Annex 16 Volume I Attachment C provides guidance on recommended maximum noise levels.

1.1 Purpose

This aerospace recommended practice (ARP) describes standard conditions and procedures for measuring, analyzing, and reporting noise resulting from operation of on-board APUs and associated equipment of aircraft undergoing servicing.

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2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 ANSI Accredited Publications

Copies of these documents are available online at <https://webstore.ansi.org/>.

ANSI S1.1-1994	American National Standard Acoustical Terminology
ANSI S1.4-1983	American National Standard Specification for Sound Level Meters
ANSI S1.6-1984	American National Standard Preferred Frequencies, Frequency Levels, and Band Numbers for Acoustical Measurements
ANSI S1.8-1989	American National Standard Reference Quantities for Acoustical Levels
ANSI S1.11-2004	American National Standard Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters
ANSI S1.13-2005	American National Standard Measurement of Sound Pressure Levels in Air
ANSI S1.15-2005	Measurement Microphones - Part 2: Primary Method for Pressure Calibration of Laboratory Standard Microphones by the Reciprocity Technique
ANSI S1.40-2006	Specifications and Verification Procedures for Sound Calibrators

2.2 ICAO Publications

Available from International Civil Aviation Organization (ICAO), 999 Robert-Bourassa Boulevard, Montréal, Québec H3C 5H7, Canada, Tel: +1 514-954-8219, <https://www.icao.int>.

ICAO Annex 16	Attachment C of Annex 16 to the Convention on International Civil Aviation, Environmental Protection, Volume I Aircraft Noise, as amended
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2.3 IEC Publications

Available from IEC Secretariat, 3 rue de Varembe, P.O. Box 131, CH-1211 Geneva 20, Switzerland, Tel: +41 22 919 0211, <https://www.iec.ch>.

IEC 60942:2003	Electroacoustics - Sound Calibrators
IEC 61094-2:2009	Electroacoustics - Measurement Microphones - Part 2: Primary Method for Pressure Calibration of Laboratory Standard Microphones by the Reciprocity Technique
IEC 61260:1995	Electroacoustics - Octave-Band and Fractional-Octave-Band Filters
IEC 61265:2018	Electroacoustics - Instruments for measurement of aircraft noise - Performance requirements for systems to measure sound pressure levels in noise certification of aircraft
IEC 61672-1:2002	Electroacoustics - Sound Level Meters Part 1: Specifications

2.4 ISO Publications

Available from International Organization for Standardization, ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, Tel: +41 22 749 01 11, <https://www.iso.org>.

ISO 266-1997 ISO International Standard for Acoustics - Preferred Frequencies for Measurements

ISO 1683-2008 ISO International Standard for Acoustics - Preferred Reference Quantities for Acoustic Levels

ISO R31/VII-1978 ISO Recommendations for Quantities and Units of Acoustics

3. GENERAL CONDITIONS:

3.1 Meteorological Conditions

Wind Not more than 5.1 m/s (10 knots)

Temperature Not less than 2 °C (35 °F) nor more than 35 °C (95 °F)

Humidity Relative humidity not less than 20% nor more than 95%

Precipitation None

Barometric Pressure Not less than 80 kPa (800 mbar) nor more than 110 kPa (1100 mbar)

Care should be exercised to ensure that wind effects do not adversely affect any measurements. For example, ambient temperature measurements could be affected if hot exhaust gases are blown into the meteorological measurement area, and the directivity and symmetry of exhaust noise can be distorted by crosswinds.

3.2 Test Site

The ground between microphones and aircraft should be a smooth, hard surface. No obstructions should be present between the aircraft and the measurement positions, and no reflecting surfaces (except the ground and aircraft) should be near enough to sound paths to significantly influence the results. The surface of the ground surrounding the aircraft should be sensibly flat and level at least over an area formed by boundaries parallel to and 60 m (200 feet) beyond, if possible, the outermost microphone array identified in item 4 of 5.2.

3.3 Background Noise

Background noise of the measurement system and test area should be determined and accounted for in all noise measurements. Background noise is the composite of: (a) pre-detection (often labeled "ambient") noise, which can contaminate measurements by contributing energy to the measured noise levels, such as noise at the microphone site from sources other than the subject being tested, or thermal electrical noise generated within the measurement instrumentation; and (b) post-detection (often labeled "floor") noise, which can obscure measured noise levels, and represents a lower limit, such as an analysis window baseline, or amplitude non-linearity exceedance. Where possible, sources of ambient noise at the site should be identified and minimized. It is desirable that the overall background noise levels be at least 10 dB below the expected aircraft ramp noise levels at all microphone locations. Recommended practice is to identify and resolve any background noise issues. Special attention should be paid to controlling noise from support equipment such as ground carts, generators, fuel delivery systems, lighting systems, and so forth. See 5.4 for a method of adjusting measured noise levels for background noise.

3.4 APU and Related Systems Installation

Pertinent APU and associated aircraft systems should be tested for each aircraft model for which acoustic data are required.

3.5 Aircraft Ground Configuration

Aircraft flight control surfaces should be in the “neutral” or “clean” configuration, with gust locks on, or as stated in the aircraft's approved operating manual for aircraft undergoing servicing. Propulsion engines should be restrained from windmilling during ramp noise testing. APU and ECS ram inlet doors should be in the correct positions for ground operation.

Ramp noise tests should be conducted with all passenger, baggage, and service doors open, in order to expedite testing. Any deviations to this configuration should be reported. This configuration is generally representative of the typical servicing configuration. However, this does not necessarily imply that the loudest conditions will be measured, since some open doors might block sound from propagating to some of the receiver locations.

4. INSTRUMENTATION

4.1 Aircraft

Operational data identified in 6.4 should be determined from normal aircraft instruments and controls.

4.2 Acoustical

4.2.1 General

Instrumentation and measurement procedures should be consistent with the requirements of the latest applicable issues of the appropriate standards listed in the references (see Section 2). All sound pressure levels should be quoted in decibels using a reference pressure of 20 μ Pa.

4.2.1.1 Definitions

Nominal 10 kHz bandwidth - Range of frequencies covered by 1/3 octave bands having nominal center frequencies from 50 through 10000 Hz

Nominal 20 kHz bandwidth - Range of frequencies covered by 1/3 octave bands having nominal center frequencies from 50 through 20000 Hz

4.2.2 Data Acquisition Systems

Instrumentation systems for recording and analysis of noise, shown in the block diagram of Figure 1, should meet the following specifications (additional guidance on suitable data acquisition systems can be found in IEC 61265).

4.2.2.1 Microphone System

Over the nominal 20 kHz bandwidth the entire system should meet the Type 1 or Class 1 requirements as outlined in the latest issue of ANSI S1.4 or IEC 61672.

Microphones should be omnidirectional, vented for pressure equalization if of condenser type, and should have known ambient pressure and temperature coefficients. Microphone amplifier specifications should be compatible with those of the microphone and data recording system.

Microphone wind screens should be employed when wind speed is in excess of 3 m/s (6 knots). Corrections as a function of frequency should be applied to measured data to account for the presence of microphone wind screens.

4.2.2.2 Data Recorder

The digital data recording system should incorporate an anti-aliasing filter prior to the analog-to-digital conversion with a cut-off frequency that is less than 0.5 times the sampling frequency. The numerical representation of the data should be sufficient to provide a dynamic range of at least 50 dB.