

Measurement of Rotorcraft Interior Sound Pressure Levels

RATIONALE

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1. INTRODUCTION: The interior noise within the relatively small space of civilian or military rotorcraft results from exterior and interior noise sources. Interior noise measurements may be required in order to develop or evaluate acoustical treatment designs that will provide a necessary degree of crew and passenger comfort.
2. PURPOSE: This document describes recommended methods and procedures for uniform measurement, analysis and reporting of sound pressure levels in the interior of rotorcraft.
3. SCOPE: Satisfactory measurements of noise in personnel-occupied rotorcraft cabins may require test techniques different from those prescribed for other types of aircraft (ARP1323) because rotorcraft operate under significantly different flight conditions. Recommendations of this ARP apply to the recording of acoustical data on magnetic tape and the subsequent processing and analysis of the recorded data.
4. MEASUREMENT PROCEDURES:
 - 4.1 Measurement Locations and Techniques: Sound pressure level measurements shall be made at crew stations and at representative locations in the passenger areas. Whenever possible, measurements are to be made with no passengers and with the minimum number of crew. The microphone height shall be at nominal ear level or seated head height at each measurement location. When practicable, measurements at a single position at each location should be avoided.

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4.1 (Continued):

One measurement technique is to move a microphone over a 20- to 40- inch (45- to 90- centimeter) path while recording the sound pressure signals. The data may be acquired by rotating the microphone around the circumference of a circle at a slow rate (approximately 5-10 seconds per revolution). The microphone shall be oriented vertically with the diaphragm facing up. Another method is to measure sound pressure levels at several fixed locations and the results subsequently averaged; at least six locations should be selected.

4.2 Operating Conditions:

- 4.2.1 Flight Conditions: Flight conditions shall include ground run at flight idle rotor speed, stabilized in-ground effect (IGE) hover, level flight at cruise airspeed, and level flight at other airspeeds normal to continuous operations or unique to a particular configuration. The rotorcraft shall be at maximum design takeoff gross weight (+5, -10%) and at maximum normal operating rotor speed. Doors, windows and vents shall be closed. The rotorcraft interior, where applicable, shall be in a fully furnished configuration with all acoustical treatment installed, for example, carpets, seats, curtains, headliners and sidewalls. Separate measurements shall be performed when more than one interior configuration or sound proofing treatment is available.
- 4.2.2 Subsystems/Equipment: All subsystems which are normally operated continuously for more than five minutes in flight shall be on during the time which acoustical measurements are made. For rotorcraft configurations equipped with an environmental control unit (ECU), measurements shall be made with the ECU on and operating in the most economical mode. Noise measurements shall be made after an initial defog, cool down or heat up period.
- 4.2.3 Data Recording: Recording of sound pressure level data on magnetic tape shall be made for at least a 30-second duration for each data point. A voice track, if available, shall be used for positive identification of each data sample. Tape recorder signal-level attenuator settings shall be monitored to ensure that signals are recorded near the optimum setting.

The following flight data shall be observed and logged during acoustical measurements:

- Initial gross weight
- Fuel burnoff
- Indicated airspeed
- Main and tail rotor speeds
- Engine power or rotor/engine torque settings, as appropriate
- Operating mode of subsystems and/or equipment

5. INSTRUMENTS:

5.1 Standards: Unless otherwise noted, all test instruments and procedures shall conform with the most recently approved revision of the standards listed below:

SAE J184 FEB87	Qualifying a Sound Data Acquisition System
ANSI S1.4A (1986)	Specification for Sound Level Meters
ANSI S1.11 (1986)	Specification for Octave-Band and Fractional-Octave Band Analog and Digital Filters
IEC Publication 651 (1974)	Sound Level Meters
IEC Publication 804 (1985)	Integrating-Averaging Sound Level Meters

Microphones shall conform with the Type 1 requirements of noise measurement systems fulfilling ANSI S1.4A or IEC 651 and shall be designed for the flattest frequency response for random-incidence sound. Tape recorders and other recording instruments or combinations of instruments shall conform with SAE J184, and applicable provisions of ANSI S1.4A. Octave-band filter sets and one-third octave band filter sets shall be at least Order 3 filters (see ANSI S1.11). The relative frequency response of a complete measurement system shall be within 2 dB of the response at the acoustical calibration frequency over the frequency range from 22.4 Hz to 11.2 kHz. Integrating-averaging sound level meters shall conform to the requirements of IEC publication 804.

5.2 Calibration: The calibration of the acoustical calibrator and the microphone shall be traceable to calibrations performed by a national standards organization. Recalibrations to manufacturer's specifications of individual instruments of the data acquisition and reduction systems shall be accomplished at intervals not to exceed six months.

Additional calibrations to supplement the laboratory calibrations consist of acoustical reference level system sensitivity checks and pink noise system frequency response checks.

System sensitivity checks shall be accomplished by placing an acoustical calibrator on the microphone(s). As a minimum, system sensitivity shall be checked at one frequency and one reference sound pressure level. It may be desirable to check sensitivity of the measurement system at different frequencies and sound pressure levels. Preferred frequencies and nominal levels are 250 Hz (124 dB) and/or 1000 Hz (94 dBA).