

AC - 44.4
001-1540

AC NO: 91-35

DATE: 28 Mar 72



ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION

SUBJECT: NOISE, HEARING DAMAGE, AND FATIGUE IN GENERAL AVIATION PILOTS

1. PURPOSE. This circular will acquaint pilots with the hazards of regular exposure to cockpit noise. Especially pertinent are piston-engine, fixed-wing, and rotary-wing aircraft.
 2. BACKGROUND.
 - a. Modern general aviation aircraft provide comfort, convenience, and excellent performance. At the same time that the manufacturers have developed more powerful engines, they have given the occupants better noise protection and control, so that today's aircraft are more powerful, yet quieter than ever. Still, the levels of sound associated with powered flight are high enough for general aviation pilots to be concerned about participating in continuous operations without some sort of personal hearing protection.
 - b. Most long-time pilots have a mild loss of hearing. Many pilots report unusual amounts of fatigue after flights in particularly noisy aircraft. Many pilots have temporary losses of hearing sensitivity after flights; and many pilots have difficulty understanding transmissions from the ground, especially during critical periods under full power, such as takeoff.
 3. DISCUSSION.
 - a. Like carbon monoxide, noise exposure has harmful effects that are cumulative - they add together to produce a greater effect on the listener both as sound intensity is increased, and as the length of time he listens is increased. A noise that could cause a mild hearing loss to a man who heard it once a week for a few minutes, might make him quite deaf if he worked in it for eight hours a
-

Initiated by: AM-100

day, five days a week. Of course, these losses of hearing would not occur overnight; they would build up progressively over a period of years. But they would occur.

- b. Recent tests conducted by the Civil Aeromedical Institute (CAMI) demonstrated that all propeller-driven, fixed-wing aircraft and all helicopters are potential sources of damaging noise intensities. The protection afforded by the cockpit is not enough to keep most active pilots from being overexposed. Part of the problem is explained by another CAMI study that showed the fatiguing effects of noise to be increased in a listener, such as a pilot, who is mentally active rather than resting. Since a pilot in command cannot rest safely during a flight, the noise may affect him more than, for instance, a passenger who is relaxing.
- c. Pilots of helicopters and of aerial-application aircraft are particularly susceptible because of the relatively high levels of noise found in these cockpits, and, in the case of aerial application, because of the long durations of noise exposure. But according to the CAMI tests, even the general aviation pilot (or crew member) who is in the air for more than three hours a week is likely to find himself slightly deaf after several years of flying. Pilots of large aircraft with maximum insulation should be safe if their unprotected ears are exposed to the cockpit noises for no more than ten or fifteen hours per week. Still, the noise in the quietest cockpits is more than ten times as intense as the noise in your car when you are driving to work. In many planes, the factor is much greater. Aircraft noise a hundred times as intense as automobile noise is common, and in the very noisy types (including some of the large military helicopters), the difference may be on the order of thousands or even tens-of-thousands.
- d. Speech is difficult to understand under noisy conditions. Cockpit noise is particularly detrimental to speech intelligibility because the engine and exhaust noises are at a maximum in the same frequency range where speech has its maximum energy. Pilots often report that, although the volume or gain control on the receiver is turned all the way up, tower transmissions are garbled or covered up, masked, by the engine noise. Tests at CAMI showed that, under takeoff conditions, the intelligibility of the tower controller can fall from 100 percent to zero.
- e. The problems are relatively easy to solve. Further CAMI experiments showed that the use of earplugs or similar hearing protection will prevent nearly every difficulty listed. The use of ear-covering devices such as earphones can also help, although precautions are necessary since the low-frequency sounds that

constitute most of the damaging energy of the cockpit noise are not adequately diminished by earcushions. Under any circumstances, a poorly fitted noise-protection device is worse than none because it gives the user a false sense of security. Thus, the usual technique of wearing only one earphone is not recommended to the pilot who wants to protect his hearing. Similarly, loose-fitting earplugs or headsets are not at all helpful. An earplug that is "so comfortable that I can hardly feel it" is not doing any good. The device need not be uncomfortable, but it MUST BE SNUG.

- f. Speech intelligibility is enhanced - improved tremendously - by the use of earplugs in the cockpit. The only people who will not reap this benefit are those who already have a severe high-tone hearing loss (these are mostly people who are particularly susceptible to the deafening effects of noise, and who therefore need to be especially careful to protect themselves from further exposure to noise for health reasons). For everyone else, the noises that are filtered out by the hearing protector are precisely the ones that interfere with understanding radio transmissions. It is only necessary to remember that, when wearing earplugs, one must speak a little louder and exert a bit more vocal effort than usual for the amount of noise being heard. Otherwise, it is easy to forget that the noise is still there, just on the other side of the earplug and must still be overcome when one talks.
- g. Plugs can be worn just as well under earphones, and the headset cushions give some added noise protection.
- h. Earplugs can be bought for as little as ten cents a pair for wax-impregnated cotton or for up to fifteen dollars for a pair of custom-made ear inserts. Plain, unimpregnated cotton is useless as a hearing protector, so a commercial earplug should be used instead. The most common varieties cost between seventy-five cents and a dollar a pair and can be used innumerable times.

4. RECOMMENDED ACTION.

- a. Use earplugs whenever flying.
- b. Use earplugs while wearing earphones.
- c. Be certain that earplugs fit snugly and that headsets are adjusted to cover both ears tightly.
- d. Use real earplugs; plain absorbent cotton does not work.

- e. Talk a little louder to the passengers and into the microphone; remember that the noise is still there and that one must speak loudly enough to overcome its effects.
 - f. Check the fit of the ear protectors by pressing earplugs with the forefinger or earmuffs with the palms. If they fit correctly, no amount of pressure will cut down on the amount of sound that is still getting through. Sometimes pressing will increase the sound because the hearing protector is being deformed and is allowing some sound to get through; ignore such increases. However, if pressing decreases the perceptible sound, adjustment is necessary. It may be that the device being used is not quite adequate; for instance, the spring in a headband may not hold the phones tightly enough, or the earplugs may be too large or too small. The point is noted here that since properly fitted earplugs form a readily broken airtight seal (if the seal were airtight, sound transmission would be greatly impaired), no problem is encountered during descents with the ambient pressure increase.
 - g. Demonstrate the effectiveness of the plugs by wearing only one during a flight of an hour or more. After shutting down the engine, remove the plug. The difference in hearing in the two ears will almost make it seem as if the ear that was open during the flight is now quite deaf. It is not, of course. It is only less sensitive because of the noise exposure, and it will recover after a little time. But that loss of sensitivity is an indication of how the noise can produce permanent damage to one's hearing.
 - h. Note the lessened fatigue after a cross-country flight. With the noise cut down, one can fly more comfortably, further, safer.
5. CONCLUSION. One can increase the pleasure and safety of flying by wearing earplugs and taking the precautions outlined above. For additional detailed information, the reader is referred to: "Cockpit Noise Intensity: Fifteen Single-Engine Light Aircraft", by J. V. Tobias, FAA Office of Aviation Medicine Report AM 68-21, September 1968, and "Cockpit Noise Intensity: Eleven Twin-Engine Light Aircraft", by the same author, AM 68-25, October 1968. Both reports are available from the Clearinghouse for Federal Scientific and Technical Information, U. S. Department of Commerce, Springfield, Virginia 22151.

PV Siegel MD

P. V. SIEGEL, M.D.
Federal Air Surgeon