APPENDIX M

NOISE

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Charles M. Schulz - Sonoma County Airport
Runway Safety Enhancement
Environmental Impact Report

Appendix M

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1.1 OUTLINE OF NOISE ANALYSIS

This report contains six (6) major sections, including this introduction. Section 2 presents background information on sound, how sound is described as noise, and the known effects that noise has on people. Section 3 describes the methodology used for this study to quantify aircraft noise exposure. Section 4 describes the baseline or existing noise in the environs of Charles M. Schulz-Sonoma County Airport (hereafter, —Airport"). Section 5 describes potential aircraft noise effects in the future with or without proposed runway extensions. Section 6 describes the Sound Exposure Levels (SEL) of a representative sampling of aircraft that operate at the Airport under current conditions and may operate under proposed runway extensions.

2.1 BACKGROUND INFORMATION

This section presents background information on the characteristics of noise as it relates to aviation and summarizes the methodologies used to study noise in an aviation environment. This section gives the reader an understanding of the metrics and methodologies used to assess noise impacts and is divided as follows:

- *Characteristics of sound that are important for technically describing sound;*
- *Factors influencing subjective human response to sound;*
- *Sound rating scales used in this study;*
- *Effects of noise on humans; and*
- *Aircraft noise regulatory context.*

2.2 CHARACTERISTICS OF SOUND

Sound Level and Frequency. Sound can be technically described in terms of the sound pressure (amplitude) and frequency (similar to pitch). Sound pressure is a direct measure of the magnitude of a sound without consideration for other factors that may influence its perception.

The range of sound pressures that occur in the environment is so large that it is convenient to express these pressures as sound pressure levels on a logarithmic scale that compresses the wide range of sound pressures to a more usable range of numbers. The standard unit of measurement of sound is the Decibel (dB), which describes the pressure of a sound relative to a reference pressure.

The frequency (pitch) of a sound is expressed as Hertz (Hz) or cycles per second. The normal audible frequency for young adults is 20 Hz to 20,000 Hz. Community noise, including aircraft and motor vehicles, typically ranges between 50 Hz and 5,000 Hz. The human ear is not equally sensitive to all frequencies, with some frequencies judged to be louder for a given signal than others. As a result of this, various methods of frequency weighting have been developed. The most common weighting is the A-weighted noise curve (dBA). The A-weighted decibel scale (dBA) performs this compensation by discriminating against frequencies in a manner approximating the sensitivity of the human ear. In the A-weighted decibel, everyday sounds normally range from 30 dBA (very quiet) to 100 dBA (very loud). Most community noise analyses, such as the evaluation of aircraft noise exposure, are based upon the A-weighted decibel scale (dBA). Examples of various sound environments, expressed in dBA, are presented in Figure 2-1[i]. The figure lists the human judgment of loudness relative to 70 dB(A).

Propagation of Noise. Outdoor sound levels decrease as the distance from the source to the receiver increases. This decrease in sound level is a result of wave divergence, atmospheric absorption, and ground attenuation. Sound radiating from a source in an undisturbed manner travels in spherical waves. As the sound wave travels away from the source, the sound energy is dispersed over a greater area, decreasing the sound power of the wave. Spherical spreading of the sound wave reduces the noise level at a rate of 6 dB per doubling of the distance.

Atmospheric absorption also influences the sound levels received by the observer. The greater the distance traveled, the greater the influence of the atmosphere and the resultant fluctuations. Atmospheric absorption becomes important at distances of greater than 1,000 feet. The degree of absorption varies depending on the frequency of the sound, as well as the humidity and temperature of the air. For example, atmospheric absorption is lowest (i.e., sound carries farther) at high humidity and high temperatures. Absorption effects in the atmosphere vary with frequency. Higher frequencies are more readily absorbed than lower frequencies. Over large distances, lower frequencies become the dominant sound as the higher frequencies are attenuated. Turbulence and gradients of wind, temperature, and humidity also play a significant role in determining the degree of attenuation. Certain conditions, such as inversions, can channel or focus the sound waves resulting in higher noise levels than would result from simple spherical spreading. The effects of meteorological conditions on sound levels are illustrated in Figure 2-2.

In addition to atmospheric absorption, aircraft noise can also be affected by the physical properties of the surrounding terrain. The magnitude of this terrain-related absorption varies with the angle of the aircraft above the horizon as measured from the observer to the aircraft. Lateral attenuation is influenced by ground reflection, refraction, aircraft shielding, and engine aircraft installation effects. In general, the lower an aircraft is, the greater the lateral attenuation. Lateral attenuation is not considered to be a factor if the angle between the observer and aircraft, as measured from the horizon, is greater than 60°. In this case, the aircraft is essentially overhead the observer.

Duration of Sound. Annoyance from a noise event rises with increased duration of the noise event (i.e., the longer the noise event, the more annoying it is). The "*effective duration*" of a sound is the time between when a sound rises above the background sound level until it drops back below the background level. Psycho-acoustic studies have determined the relationship between duration and annoyance and the amount a sound must be reduced to be judged equally annoying for increased duration. Duration is an important factor in describing sound in a community setting.

The relationship between duration and noise level is the basis of the equivalent energy principal of sound exposure. Reducing the acoustic energy of a sound by one-half results in a 3 dB reduction. Doubling the duration of the sound increases the total energy of the event by 3 dB. This equivalent energy principal is based upon the premise that the potential for a noise to impact a person is dependent on the total acoustical energy content of the noise.[ii] Defined in subsequent sections of this study, noise metrics such as Community Noise Equivalent Level (CNEL), Equivalent Noise Level (Leq), and Sound Exposure Level (SEL) are all based upon the equal energy principle.

Figure 2-1

EXAMPLES OF VARIOUS SOUND ENVIRONMENTS IN dB(A)

dB(A)	OVER-ALL LEVEL Sound Pressure Level Reference: 0.0002 Microbars	COMMUNITY (Outdoor)	HOME OR INDUSTRY	LOUDNESS Human Judgement of Different SoundLevels
130		Military Jet Aircraft Take-Off With After-burner From Aircraft Carrier @ 50 Ft. (130)	Oxygen Torch (121)	120 dB(A) 32 Times as Loud
120 110	UNCOMFORTABLY LOUD	Concord Takeoff (113)*	Riveting Machine (110) Rock-N-Roll Band (108-114)	110 dB(A) 16 Times as Loud
100		Boeing 747-200 Takeoff (101)*		100 dB(A) 8 Times as Loud
90	VERY LOUD	Power Mower (96) DC-10-30 Takeoff (96)* Motorcycle @25 Ft. (90)	Newspaper Press (97)	90 dB(A) 4 Times as Loud
80		Car Wash @ 20 Ft. (89) Boeing 727 w/ Hushkit Takeoff (96)* Diesel Truck, 40 MPH @ 50 Ft. (84) Diesel Train, 45 MPH @ 100 Ft. (83)	Food Blender (88) Milling Machine (85) Garbage Disposal (80)	80 dB(A) 2 Times as Loud
70	MODERATELY LOUD	High Urban Ambient Sound (80) Passenger Car, 65 MPH @ 25 Ft. (77) Freeway @ 50 Ft. From Pavement) Edge, 10:00 AM (76 +or- 6) Boeing 757 Takeoff (76)*	Living Room Music (76) TV-Audio, Vacuum Cleaner	70 dB(A)
60		Propeller Airplane Takeoff (67)* Air Conditioning Unit @ 100 Ft. (60)	Cash Register @ 10 Ft. (65-70) Electric Typewriter @ 10 Ft. (64) Dishwasher (Rinse) @ 10 Ft. (60) Conversation (60)	60 dB(A) 1/2 as Loud
50	QUIET	Large Transformers @ 100 Ft. (50)		50 dB(A) 1/4 as Loud
40		Bird Calls (44) Lower Limit Urban Ambient Sound (40)		40 dB(A) 1/8 as Loud
20	JUST AUDIBLE	Desert at Night (dB[A] Scale Interrupted)		
10	THRESHOLD OF HEARING			

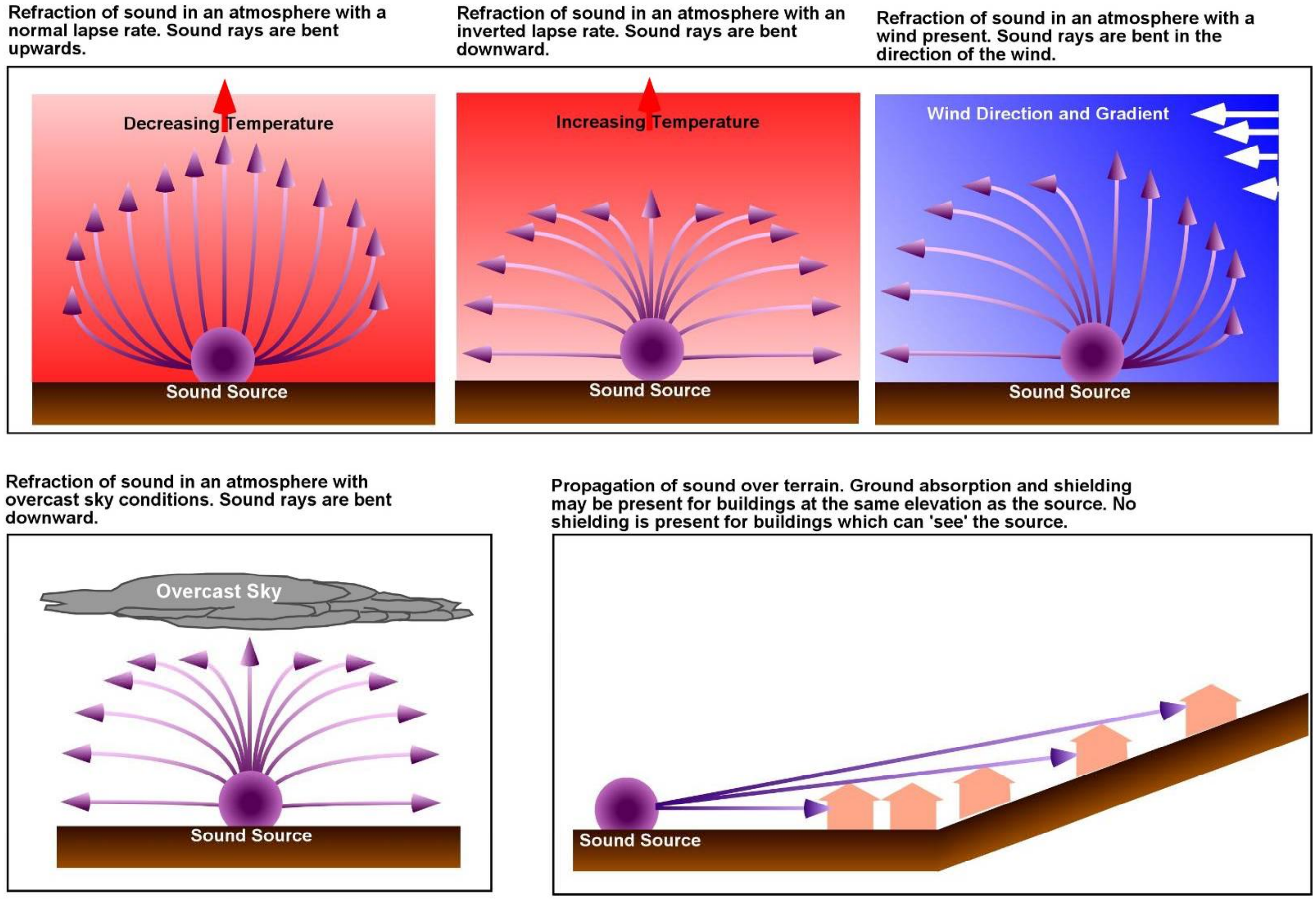
Numbers in Parentheses are the A-Scale Weighted Sound Levels for that Noise Event

****Aircraft takeoff noise measured 6,500 meters from beginning of takeoff roll***

SOURCE: FICON (1992)

Figure 2-2

EFFECTS OF WEATHER AND TERRAIN ON SOUND PROPAGATION



SOURCE: ACRP, *Effects of Aircraft Noise: Research Topic on Selected Topics* (2008).