University of Southern California	**Prof. Schiler**
School of Architecture	**Spring 2005**
Arch 315: Design of the Luminous and Sonic Environment	**Homework Assignment #5**

1. The city of Inglewood is building a branch library next to Los Angeles International Airport. Aircraft passing 3000 feet above the proposed site which you are evaluating produce a sound Intensity Level of 70 decibels (dB) measured at the ground below. The planes always follow an east-west path when approaching the runway.

   A.) What is the sound power in watts radiated by the aircraft?

   $IL = 10 \log (I/I_0)$
   where IL is Intensity Level, in dB
   I is Intensity, in w/cm^2
   I_0 is Reference Intensity (i.e.,10^{-16} w/cm^2, the threshold of hearing)
   log is logarithm to base 10

   $70\ dB = 10 \log (I /10^{-16})$
   $7 = \log (I/10^{-16})$
   $\log (10^7) = \log (I /10^{-16})$
   $10^7 = I /10^{-16}$
   $I = 10^{-9}\ w/cm^2$

   $I = w/(4*\pi*d^2*930)$
   where I is, Sound Intensity,in w/cm^2
   w is Sound power, in watts
   d is distance, in ft
   1 ft^2= 930 cm^2

   $w = I * 930 * 4 * 3.14159 * 3000^2$
   $w = 105.13$ w

   B.) What would be the IL (in dB) at an alternative site 4000 feet to the north?

   $I_2 = (d_1/d_2)^2 I_1$
   I, Sound Intensity,
   d, Distance from sound source to site.

   $I_2=(d_1/d_2)^2 * I_1$
   $=(3000/5000)^2 * 10^{-9}$
   $= 3.6*10^{-10}\ w/cm^2$
   $IL_2=10 \log(I_1/I_0)$
   $= 10 \log(3.6*10^{-10}/10^{-16})$ $(w/cm^2 / w/cm^2)$
   $= 10 \log (3.6 * 10^7)$
   $= 65.56$ dB

2. A firetruck siren sounding outdoors gives a maximum sound intensity level (IL) of 110 dB at 10 feet. What intensity level would be observed at a distance of 80 feet with four firetruck sirens of the same power going at the same time?

   If $D_2=2D_1$, then $IL_2= IL_1$-6dB ;
   If $W_2=2W_1$, then $IL_2= IL_1$+3dB ;
   Two trucks creating 110 dB each would be 110 dB + 3 dB = 113 dB
   Four trucks creating 110 dB each would be 113 dB + 3 dB = 116 dB
   The sound intensity level at 20 feet would be 116 dB - 6 dB = 110 dB

The sound intensity level at 40 feet would be 110 dB - 6 dB = 104 dB
The sound intensity level at 80 feet would be 104 dB - 6 dB = 98 dB
or
$IL_2=IL_1-3*6dB+2*3dB=98$ dB

3. The inverse square law usually gives a good approximation of the decrease in sound intensity with distance from the source in outdoor situations. List at least two reasons that this approximation might not give precise results in evaluating a given outdoor situation.

   The ground is likely to reflect sound, as is any wall against which a sound source is standing. This would reinforce the sound and result in less decrease.
   Sound also carries better and more rapidly in warmer air, curving the sound path if the air is warmer near the ground or vice versa.