



DESIGN GOALS REALIZED IN THE *INFINITE ENVIRONMENTS THEATER*

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Design goals for the INFINITE ENVIRONMENTS THEATER were:

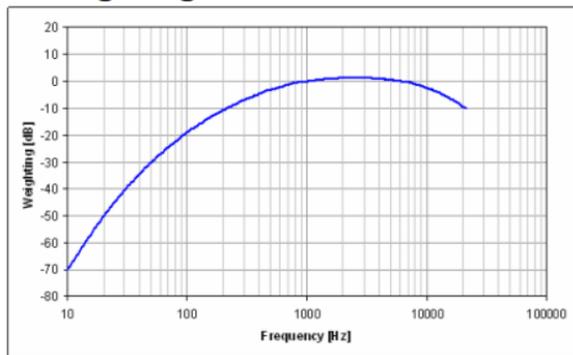
- A pristine dynamic range exceeding the capability of all current theaters - from silence to thunderous.
- Accurate digitally equalized frequency response from the lowest organ pedal of 8 Hz to beyond the upper range of human hearing.
- Spatial accuracy over a wider range of seating positions than any existing theater.

An important lesson that we at Cerwin-Vega! taught the audio community back in the 1970's, with the Sensurround system used in the Universal Studios movie Earthquake was the transformational nature of the listening experience as the power of the lowest frequencies of sound was increased. The sensation of loudness grows with a logarithmic function, as does the sensation of vibration, but the vibratory sensation grows more quickly with level than loudness. It requires a threshold of SPL above about 115 dB to start shifting the focus to total body involvement, rather than merely listening. It is actually quite useful that the hearing loss damage risk criterion curve is down weighted (the A-Weight curve) such that 30 Hz is 40 dB less damaging than 1 kHz. So 125 dB at 30 Hz, while it can be quite thrilling, is no more risky than 85 dB in the midband, which is the OSHA standard for all day exposure in the workplace. THX and ATMOS theaters have an upper SPL limit of 105 dB in the midband, and only 115 dB in the LFE channel, thus they fall short of being able to deliver a transformational, enveloping, fully involving experience. The INFINITE ENVIRONMENTS THEATER takes full advantage of this effect with the use of 18 square feet of diaphragm area in the four subwoofers placed in a horizontally opposed boxer configuration to eliminate inertial vibration effects. The subs are driven with 24 kW of power. Total system power is 53 kW.

Spatial accuracy from the 7 channels of nearly full range (100 Hz to 20 kHz) floor to ceiling line source arrays assure uniform sound experience at every seating location. A point source speaker as are all conventional speakers such as used in THX applications have a sound level decay of 6 dB per doubling of distance. The line arrays in the INFINITE ENVIRONMENTS THEATER, since they reflect both downwards and upwards from the ceiling and floor surfaces act nearly as perfect infinite lines, thus the decay is half as much as a point source, or 3 dB per doubling of distance. This has the effect of creating an enveloping, comfortable listening experience that must be heard to be appreciated.

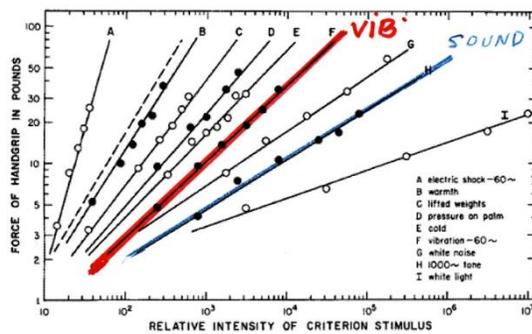
Some basic psychoacoustic data:

A Weighting



The graph above shows the A Weight curve, which represents an approximate loudness as a function of frequency at low levels, and also represents the damage risk to the ears as a function of frequency.

Graph below: Sensation Intensity over a range of Stimulus level for various modalities. The Yellow line is vibration, while the Blue line is loudness. The vibration sense rises much more rapidly than loudness, as level increases. This is important, as we exploit it to create a visceral experience.



Perception & Psychophysics, 1966, Vol. 1

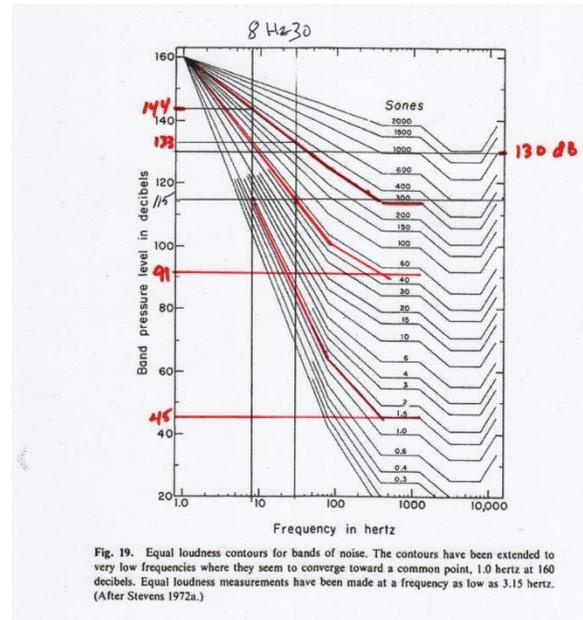


Fig. 19. Equal loudness contours for bands of noise. The contours have been extended to very low frequencies where they seem to converge toward a common point, 1.0 hertz at 160 decibels. Equal loudness measurements have been made at a frequency as low as 3.15 hertz. (After Stevens 1972a.)

The equal loudness graph above from S.S. Stevens extends the data to 1 Hz. Note that it takes much more stimulus level to make low frequencies sound loud.

Some interesting comparisons are:

115 dB at 1 kHz is 300 Sones; to hear 30 Hz this loud requires 133 dB, which we can do. It would need 144 dB at 8 Hz to equal 300 Sones, which we aren't yet doing.

91 dB at 1 kHz needs 115 dB at 30 Hz, which is easy for the IE Theater. 8 Hz requires 133 dB which we aren't doing yet.

45 dB at 1 kHz is 1.5 Sones. 8 Hz needs 115 dB to equal this loudness, which we can do.

Summary

The Infinite Environments Theater can deliver an aural and visceral experience that truly must be heard to be understood.