Environmental Lab

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Ergonomics

1. Introduction

The purpose of this lab is to measure aspects of the environment, specifically noise, heat, humidity, and lighting and to relate these factors to human productivity in the work place. When any of these factors exceed the recommended standards human stress occurs and productivity is lowered.

2. Noise

2.1 Audiometric Survey

Hearing may be accurately measured on an audiometry machine. The meter is set up so that the listener cannot see settings or interpret from the tester's body language that a signal is being sent. The range of decibels is tested in gradually increasing intervals from low to high (0 to 70 dB) for a range of frequencies from low pitched sound at 250 to high pitched frequencies of 8,000 hertz.

Results are shown in Graph 1.

Fig. 1: Audiometric Survey of Hearing

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Insert Graph 1 Here

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The graph indicates some minor hearing loss in both ears at the lower frequencies. Hearing improves in the higher frequencies, although less so in the right ear at 6000 hertz. The greatest sensitivity is at 4000 hertz. In general, the hearing is excellent and would cause no impediments in the work place. A hearing

impairment is defined as an average hearing threshold shift in excess of 15 dB at 500, 1000 and 2000 hertz(McCormick & Sanders, 1987).

The above results contrast with the norm. The human ear is less sensitive at low frequencies and more sensitive at higher frequencies. Hearing loss normally occurs around 4000 db and spreads to a range from 3000 to 6000. Results may have been confounded by initial room noise and unfamiliarity with the tones.

Sound Levels

A sound pressure meter was used to take readings around the campus. Using ANSI standards the meter measures on the A, B and C scales. The A scale is used to measure environmental noise and approximates the response characteristics in human hearing. The C scale weighs all frequencies equally and does not conform with human hearing. The long term average sound level or Leq (equivalent sound) level, a measure used for the size of environmental noise was also measured over a 30 minute period. TTS or temporary threshold shift is used to measure hearing loss caused by continuous sound levels. Results are presented in Fig. 2.

Fig. 2: Sound Level Readings on Murdoch Campus

Insert
Fig. 2 Here

Interpretation of the results indicates that all levels of noise are below the minimal standards of 90 dB shown to cause hearing loss over long periods. The Leq sustained average was 55 and

this level falls within the range of clerical environments. The cafeteria was the noisiest environment and the library the quietest. The library compares with the 42 dB level in a quiet home(McCormick & Sanders, 1987).

2. Heat

For the body to operate comfortably, a body core temperature of 37 C must be maintained.Heat exchange occurs via convection, evaporation (sweating), radiation or conduction. Heat exchange is influenced by air temperature, humidity, air flow and temperatures of the surrounding environment.With high air and contact surfaces cooling occurs by evaporation. This process is limited by the amount of moisture in the air or humidity. Humidity is calculated by comparing readings of a wet and dry bulb thermometer.

The wet bulb, wet with water, is cooled by evaporation caused by air movement from swinging the instrument for one and a half minutes. The reading is below the temperature of the dry bulb. The relative humidity rating is calculated by subtracting the wet from the dry reading and consulting a table.

The black body thermometer is a wet thermometer enclosed in a large copper black bulb which is heated by radiation. An index of radiative heat is provided. This index is called the WBGT index. The index combines the effects of dry heat with humidity and radiation. The WBGT formula is (.7 wet temperature)*(.2 Black bulb)*(.1 dry temperature).

The ET or effective temperature is an index to equate temperature, humidity and air currents. A effective temperature of 21 C is characterised by a sensation of 21C with 100 percent humidity.

Heat stress indices or HSI is the ratio of heat load caused by metabolism, convection and radiation to the evaporative cooling potential of the surroundings. This index measures the ability of the body to shed heat.

The physiological effects of heat stress is higher rectal temperature, increased heart rate and dehydration. Performance decreases with people undertaking light work better tolerating higher WBGT. Heavier work requires more frequent rest breaks. A table of permissible workloads for continuous work during the day at given temperatures indicates 75% rest per hour at 30 WBGT and 500 Kcal/Hr(Cormack and Saunders, 1987). These writers note that mental and cognitive tasks are impaired the least, followed by tracking and dual tasks. Exposure is also traded off against the degree of ET. Longer exposure lowers the degree of ET required to affect performance.

Readings around campus are shown in Table 2.

Table 2

	Cafeteria	Library	Bush Court
Wet Bulb C	21.5	19.5	21.5
Dry Bulb C	24	23.5	22.5
Black Bulb C	23	23	23
Rel Humidity	79	69	92
WBGT Index	166.2	147.6	155.8
ET* Scale C	24	23.5	23

These results indicate values in the comfort range in the library

and mild humid weather outdoors. The cafeteria because of its lack of air conditioning falls between the two poles. All conditions are acceptable and would not cause stress or limit work.

3. Lighting

White light includes all wavelengths of the spectrum, and is defined as radiant energy capable of exciting the retina of the eye. The dominant wave length determines colour. Luminance is the value associated with reflected light and gives us our awareness of brightness. Luminous flux is the measurement quantity measured in lumen (lm). Luminous intensity is measured in candela (cd). Saturation or purity refers to the presence of a narrow range of wavelengths, giving colour or chroma. Any colour can be created by mixing the three primary colours, red, green and blue.

Effects of Lighting on Performance

Although performance levels off with increased levels of illumination, higher levels of illumination may increase mental capacity by increasing visual acuity. Excessive illumination may cause glare and eye strain. Sanders and McCormack provide standards suggesting 500 to 1000 lux for medium contrast visual tasks such as reading medium pencil hand writing. In comparison the following classroom measures were found.

Measurements in the classroom appear in Table 3.

Table 3: Light Readings in the Classroom

Light reading of luminous intensity (Brightness)

6800 to 7200 at 1 meter.

Average 7000 candela

Reflected Light from Desk (Illumination)

368 to 384 lux

Measurement of Illumination of a work place

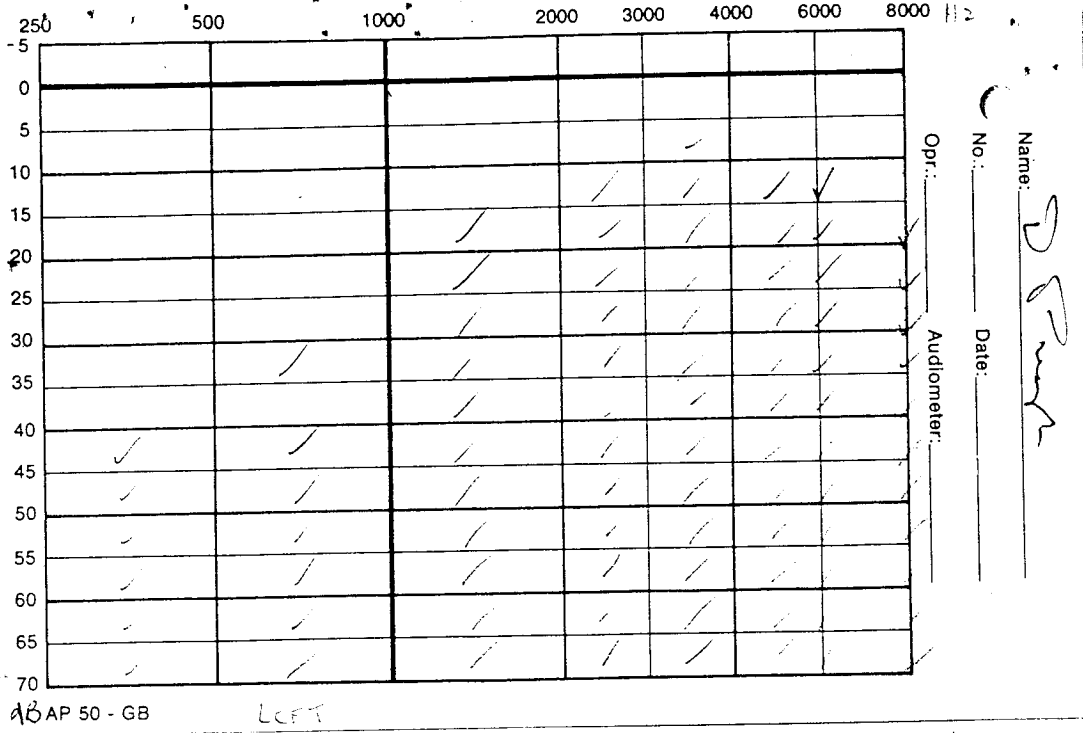
243 to 275 lux

This lighting level is recommended as suitable for high contrast visual work such as reading printed material(Sanders & McCormick, 1987, 408). The level is satisfactory for a classroom. It would be inadequate for intensive drafting requirements. Increased lighting levels may be required for elderly people.

The reflected luminance from the desks may be excessive, causing reflected discomfort glare. Glare refers to greater brightness than the luminance to which the eye is adjusted.

4. Conclusion

Comfort in terms of heating, lighting, and noise levels are essential for optimal functioning of human beings. This laboratory has demonstrated that conditions within the university generally meet the standards for comfort presented by Saunders and McCormick (1987).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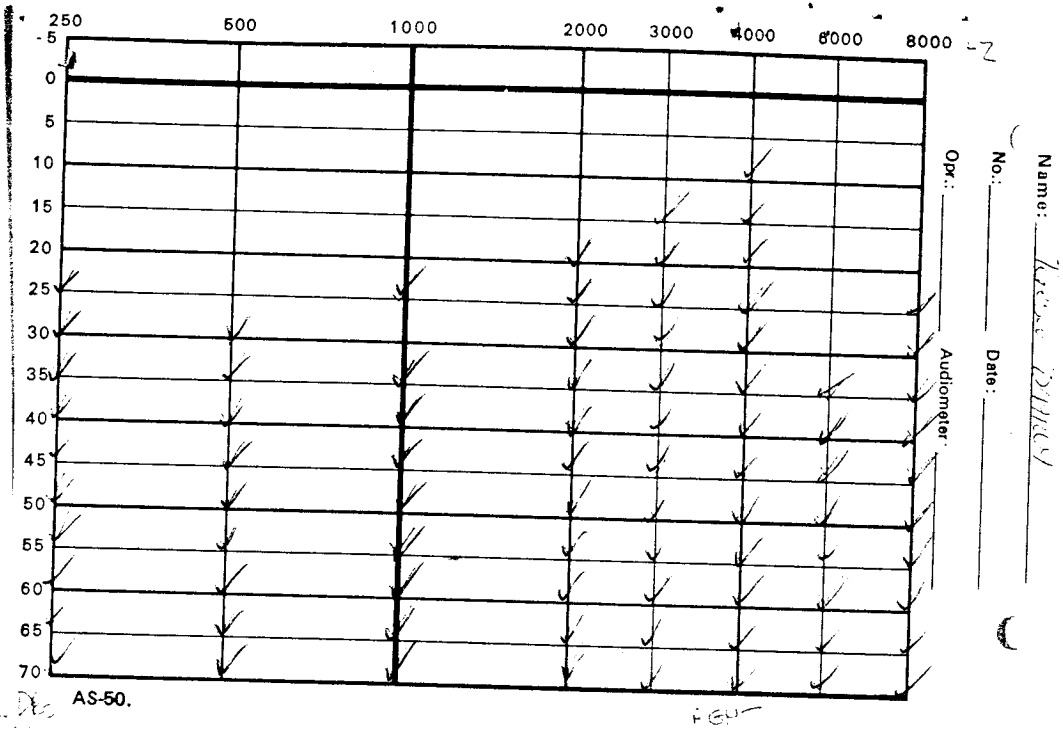
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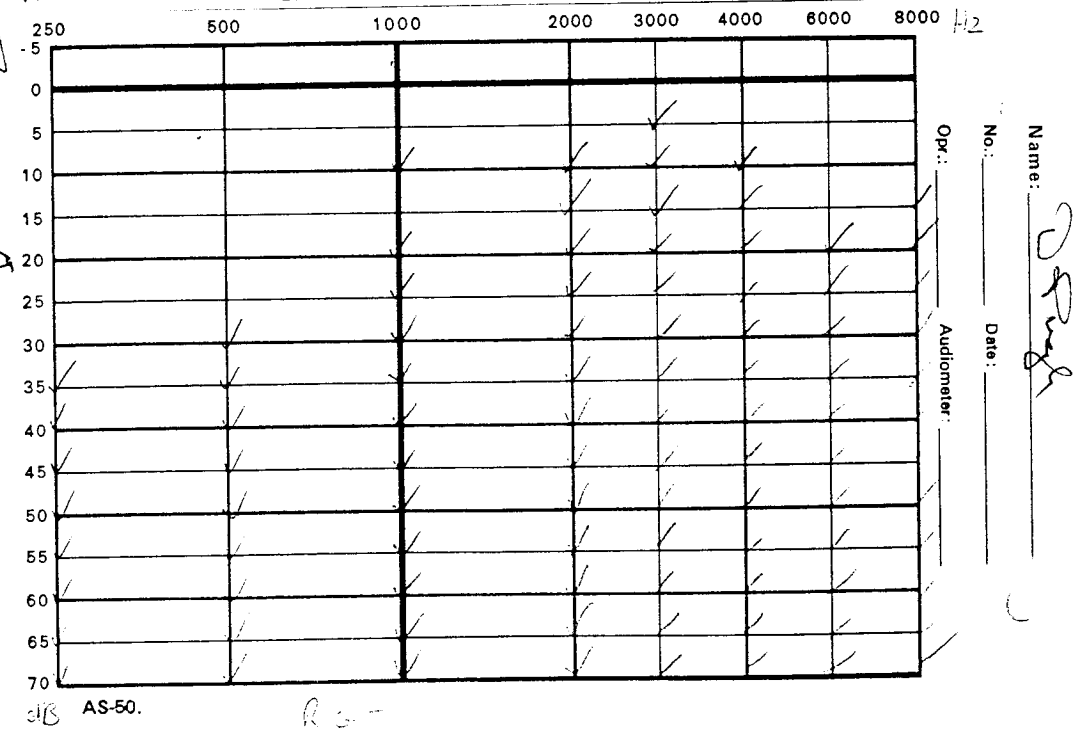
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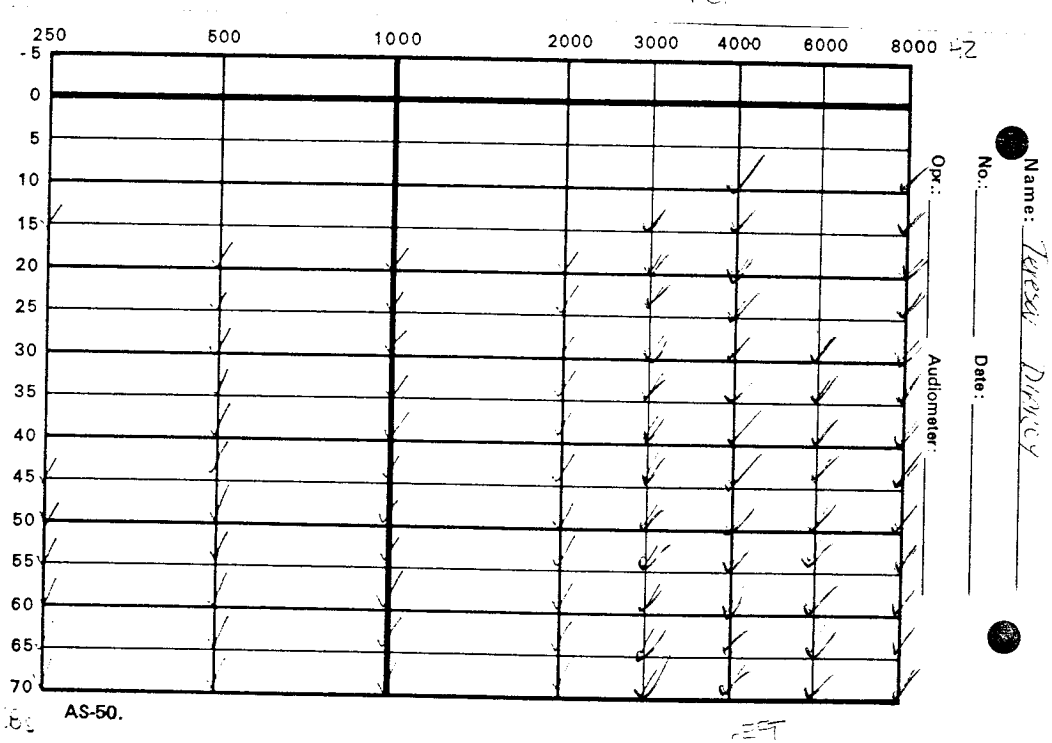
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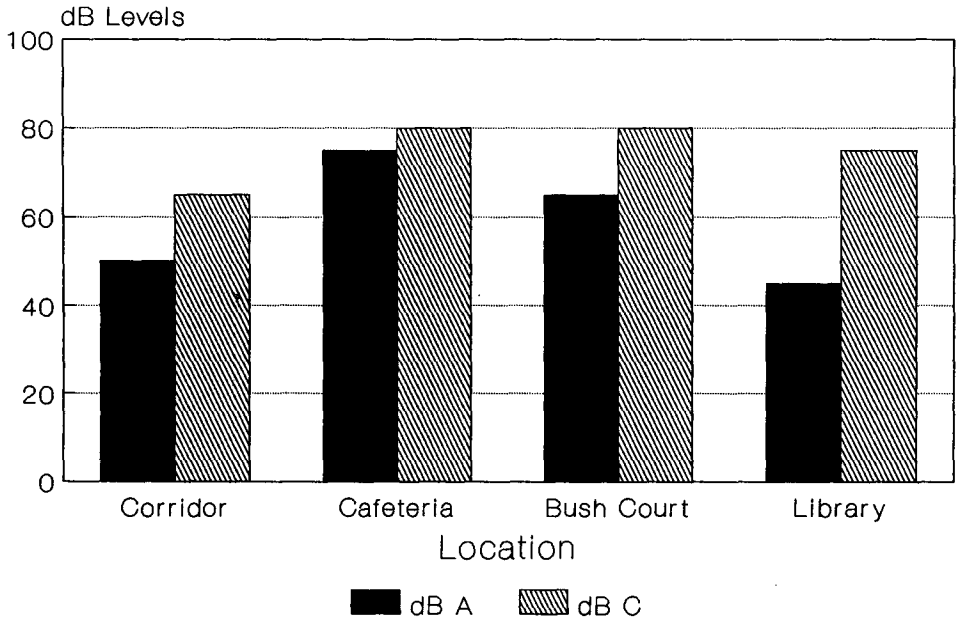
Noise Levels on Campus



MEASUREMENT SCALES

Fig 2