OUTDOOR NOISE LEVELS AT YILDIZ TECHNICAL UNIVERSITY ISTANBUL, TURKEY

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ABSTRACT

In this study, noise measurements for relevant 22 outdoor points and some indoor ambience for sensitive places such as kindergarten, classrooms, library and exhibition centre at the central campus area of Yildiz Technical University were made. A map developed evaluated hourly noise values obtained for 5 months. By using the map, noise control measures that have to be taken for subject area were determined. Measurements were performed in accordance with the Turkish Standards, by using HD 9019 Sound Level Meter. The map consisting from isoline curves of noise levels (Leq dBA) was developed by the Spherical Krigging method. The study showed that Barbaros Boulevard side of the area (front side of the University) generally has 78 dBA originated from traffic noise completely. Unfortunately, in front of the University there was much heavier traffic jam due to stops, crossroads and an overpass for vehicles. Therefore, higher noise isolines were obtained at the front of the University. This level noise is not adequate for an education purpose area. 76 per cent of the all campus area had higher noise levels than 55 dBA standard.

SOMMAIRE

Dans cette étude, les mesures de bruit pour les 22 points extérieurs appropriés et un certain ambience d'intérieur pour les endroits sensibles tels que le jardin d'enfants, les salles de classe, la bibliothèque et le centre d'exposition à la zone centrale de campus de l'université technique de Yildiz ont été faits. Une carte développée a évalué des valeurs horaires de bruit obtenues pendant 5 mois. En utilisant la carte, des mesures de lutte contre le bruit qui doit être prise pour le domaine ont été déterminées. Des mesures ont été exécutées selon les normes turques, en utilisant le mètre de niveau sonore de HD 9019. La carte consistant des courbes d'isoline des niveaux de bruit (Leq dBA) a été développée par la méthode sphérique de Krigging. L'étude a prouvé que le côté de boulevard de. Barbaros de la zone (partie antérieure de l'université) a généralement 78 dBA provenus du bruit du trafic complètement. Malheureusement, devant l'université il y avait bourrage de circulation beaucoup plus dense dû aux arrêts, au carrefour et à un passage supérieur pour des véhicules. Par conséquent, de plus hauts isolines de bruit ont été obtenus à l'avant de l'université. Ce bruit de niveau n'est pas adéquat pour une zone de but d'éducation. 76 pour cent de la toute la zone de campus ont eu des niveaux plus élevés de bruit que la norme de 55 dBA.

1 INTRODUCTION

Classroom is a type of room that has to meet a suitable level of acoustical quality. In general, teachers aim to say everything in their mind to students, without getting bored. Meanwhile students intend to understand everything what teacher says. Therefore, background noise level in a classroom should be obtained for high acoustical standards in terms of noise criteria values. (Sargent, *et al.* 1980)

Acoustical quality requirements of classroom in various European Countries vary between 30-45 dBA Leq (Bel: 30-45, Fra: 38, Ger: 30, Ita: 36, Por: 35, UK: 40, Swe: 30 and Tur: 45 dBA). For these countries, acoustical quality requirements in other education related places like library, office, dinning room etc. are almost similar. (Vallet, 2000)

Noise from outdoor sources penetrates through windows and other weak parts of building structures. Adequate isolation precautions should be considered during project and construction of educational buildings to be built in areas having high outdoor noise levels.

In this study, a survey to investigate the effect on classrooms and other educational places at the university campus of outdoor noises (mainly traffic originated) is investigated. Following a field study, a noise map for the area was developed as a tool in order to evaluate the effect of existing outdoor noises.

2 OUTDOOR NOISE SURVEY

Central campus of Yildiz Technical University, which is located on the Barbaros Boulevard in Besiktas district of Istanbul, has a capacity of 15,000 students. There are two daily education periods at the university - day and evening classes. Total area of the central campus is 113,400 m^2. The Barbaros Boulevard is one of the most crowded main roads in Istanbul. Hourly vehicle counts on the boulevard for different day times were determined as shown in Table 1. The table indicates that traffic through the day on the boulevard changes in a wide range, during day's hours.

There is also a connection highway to the First Bosphorus Bridge, which connects the European side to Asian side of Istanbul and is just beside of the central campus. As can be seen from Figure 1, the campus is located in heavily congested arteries connecting commercial parts to residential parts of Istanbul. In this study, a total of 22 noise measurement points representing influences of various noise sources is shown on the map in Figure 1. These measurement points were both inside and near the surrounding area of the campus.

The measurement studies were carried out for a period of five-months, from August to December in 1997. Measurements were made for two days per month during the study. Noise levels were measured in 16 points in the first days and 6 points in the second days of the months. At all points, daily measurements were made for five time intervals as: 06.00-08.00 a.m., 10.00-12.00 a.m., 14.00-16.00 p.m., 18.00-20.00 p.m. and 24.00-02.00 a.m. Thus, noise level fluctuations during the whole day were obtained. During the study, acoustic measurements were made according to the Turkish Standards Institute method no TS.9315. (Turkish Standards Institute, 1991)

Table 1. Vehicle/hour values for different day times on the Barbaros Boulevard

	Time of the day		
	8.00-9.30	**12.00-13.00**	**18.00-19.00**
Number of measurements	20	20	20
Max	7068	5844	7056
Min	564	708	1008
Mean	2791	2723	3053

For all these out-door acoustic measurements, taking into consideration almost similar local meteorological conditions such as wind velocity, wind direction, temperature and humidity has been a governing factor to get meaningful measurement data. All the measurements were performed

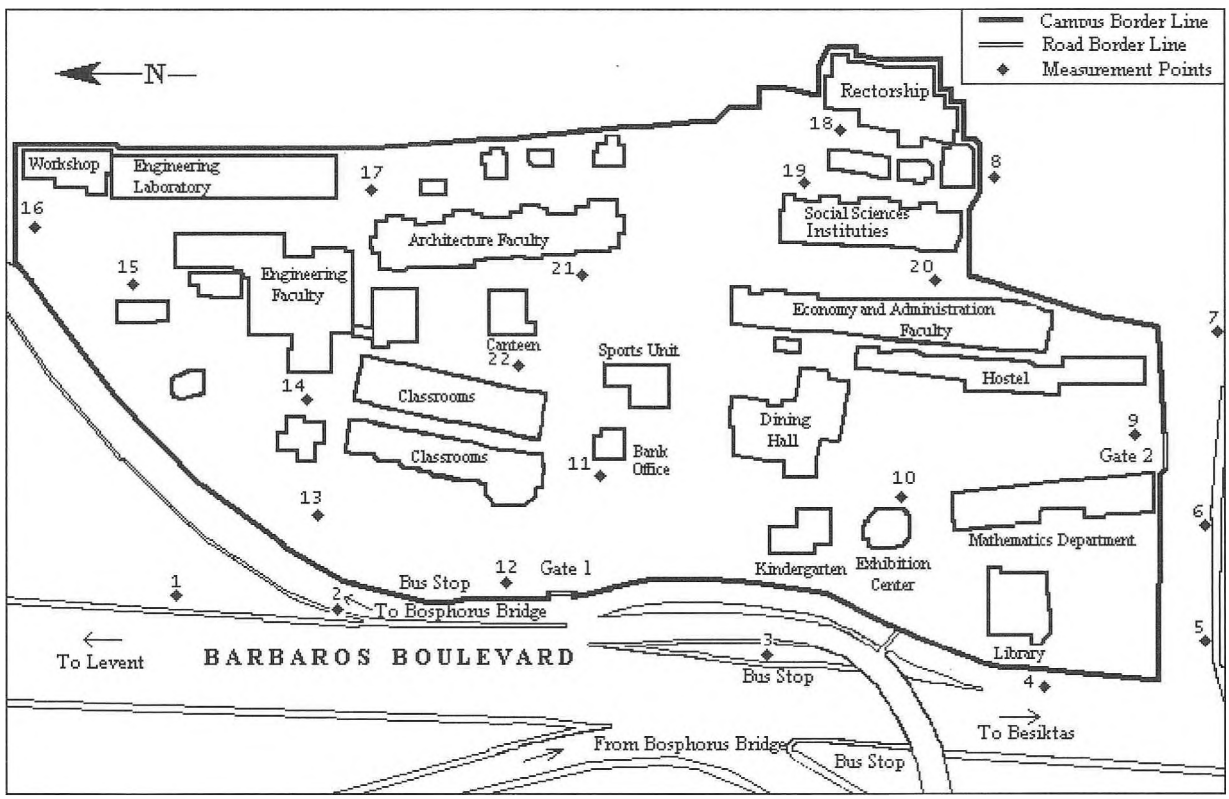

Figure 1. Map of Yildiz Technical University Campus and Noise Measurement Points

when there was no precipitation (rain or snow). Daily meteorological parameters were obtained from Istanbul Division of State Meteorological Works Department.

According to the measurement standard, a measurement point must be at least 1 meter away from reflective surfaces to prevent interference of sound waves. Therefore, while the noise levels on a point close to a reflective building or materials were measured, a distance of at least 1-meter from these surfaces was maintained.

On the other hand, for road traffic noise measurements, related Turkish Standard numbered TS 10713 was used (Turkish Standards Institute, 1993). According to the Sstandard, noise measurement points should be 3.5m from road, and height of the microphone of the equipment should be between 1.20 and 1.50 m.

The minimum measuring time for each point was 5 minutes. Noise level determinations were made with HD 9019 Sound Level Meter Class 1, HD 9102 Calibrator, a ½"condenser microphone and a tripod.

Noise map developing process for subject area was made by spherical krigging method by means of software. The method generates visually appealing contour and surface plots from irregularly spaced data. During gridding process, average noise values of five months (L_{Aeq}) at measurement points were used.

3 RESULTS AND ANALYSIS

Noise level values measured as L_{Aeq}, L_{10}, L_{50} and L_{90} through 5 months at the 22 points are presented in Figure 2a to 2d, respectively. The figures include averages of the five months' L_{10}, L_{50}, L_{90} and L_{Aeq} values in dBA. Since the physical character of each noise measurement point is not same, measured noise levels obtained for each point are different from other points. This variation is obviously related to proximity of the point to the Barbaros Boulevard. First 5 points having the highest noise levels shown in Figure 1 are near or quite close to the Boulevard. On the contrary, last 6 points (17, 18, 19, 20, 21, and 22) have the quietest part because of being inside the campus. There is no educational activity at these points, and they are recreational area. Noise values are quite hight at point 12, just inside the campus near the boulevard. Figure 3 indicates max, mean and min values for each measurement point, and describes above the reasoning much more clearly.

Figures 4a to 4e also present additional measured data that show noise variations in the area for 24 hours. These data clearly show the effect of traffic jam. Especially during the early day times it is much more silent. After the start of working hours, noise values increase. The highest values were measured between 6 and 8 p.m. It is clear that evening traffic generates more noise than morning traffic. This is due to proximity of the Bosphorus Bridge to the University. In the morning, there is congested traffic at the Asian side of the bridge. On the other hand, there is congested evening traffic in front of the University in the evening, especially before the bridge. Another cause of higher evening noise level is obviously due to upward slope of 4-6% of the Boulevard, increasing to the University from Besiktas.

Data that are obtained from average L_{Aeq} value of the five months were used to develop noise map of the central campus. The noise map developed is presented in Figure 5. Traffic originated noise propagation in the university campus area can be seen clearly from the noise map. As can be

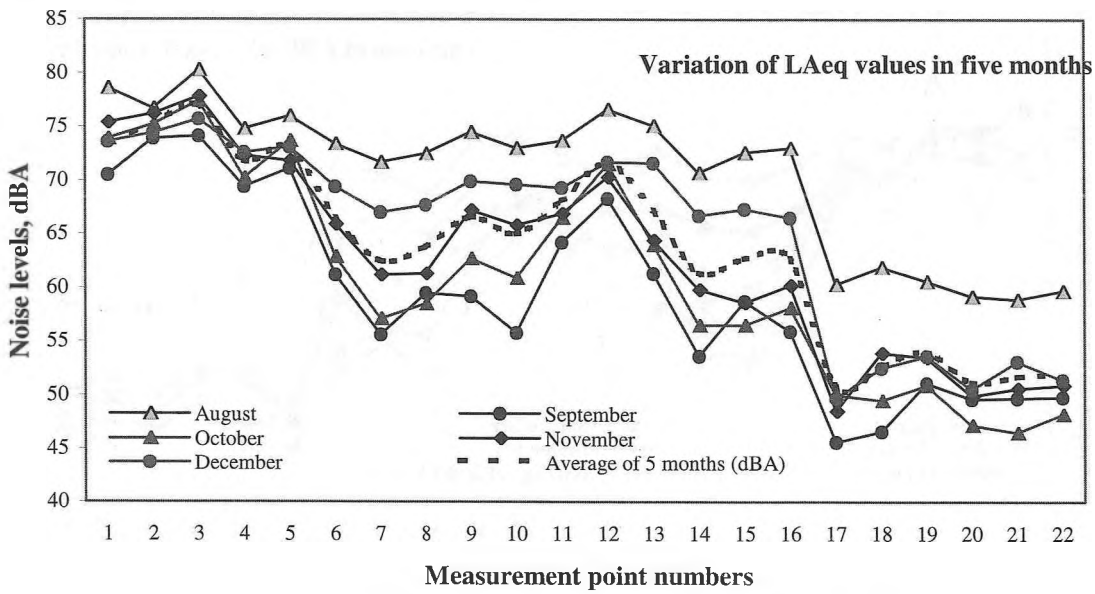

Figure 2a. Noise level values measured through 5 months at the 22 points as L_{Aeq}

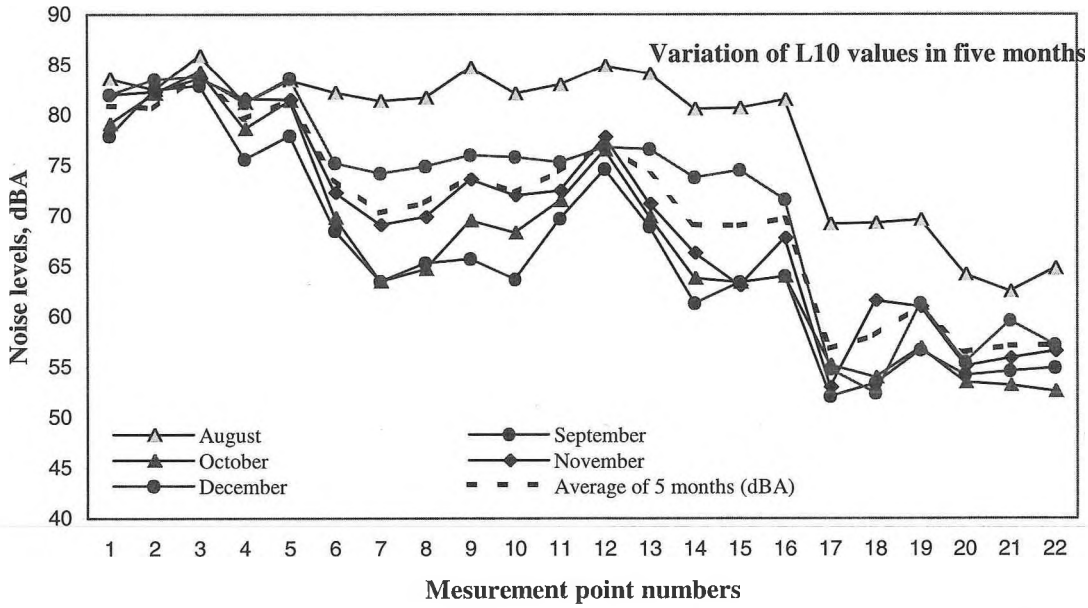

Figure 2b. Noise level values measured through 5 months at the 22 points as L_{10}

seen from the map, 76 per cent of the campus area has higher noise level than 55 dBA for standard outdoor levels. The highest noise contour is on the boulevard upto 78 dBA, just near to side of the university. The noise resulted from the boulevard effects buildings of classrooms, kindergarten, library and Engineering faculty negatively. University staff and students do complain about annoying sound level. Measured indoor noise values (L_{Aeq}) with open or closed windows are given in Table 2. All these media have higher values than 45 dBA standard value.

4 CONCLUSION

The outdoor and indoor noise measurements indicate that the noise levels are not acceptable for a university or other type educational areas.

According to the Turkish Noise Control Regulation, acceptable outdoor noise levels at educational areas, for daytime and evening time are 55 and 50 dBA, respectively. By comparison with these outdoor standards, noise levels that traffic originated in majority, at the central campus of the University are not acceptable. (Noise Control Regulation of Turkish Republic 1986)

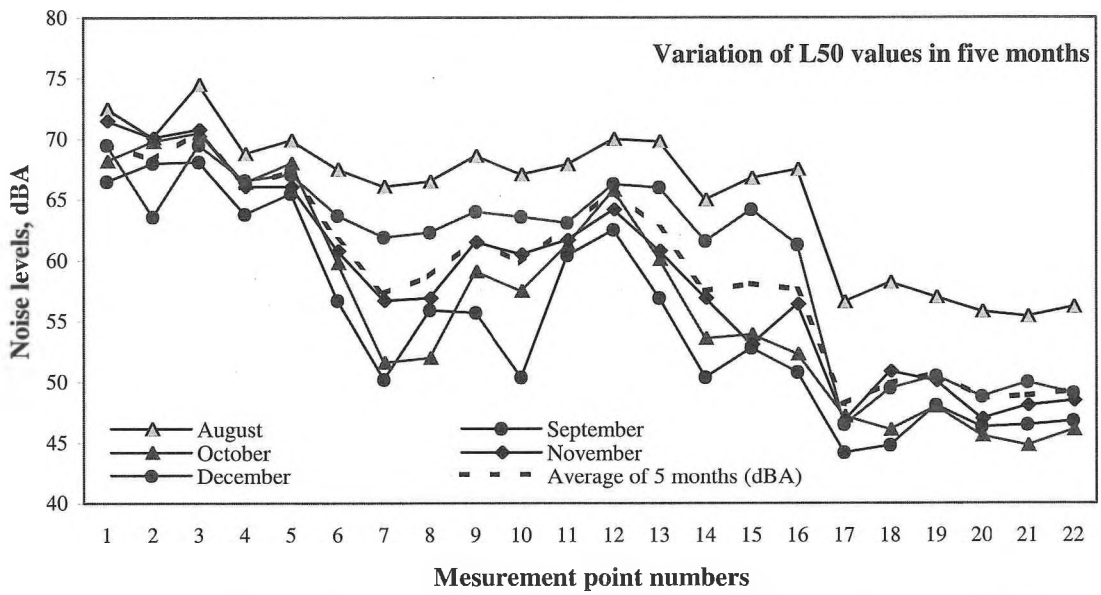

Figure 2c. Noise level values measured through 5 months at the 22 points as L_{50}

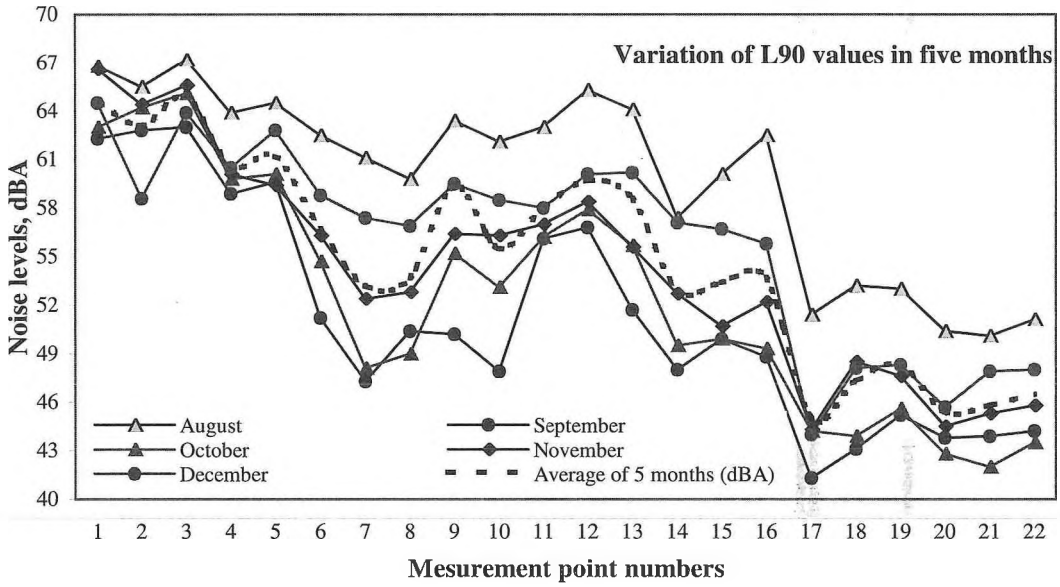

Figure 2d. Noise level values measured through 5 months at the 22 points as L_{90}

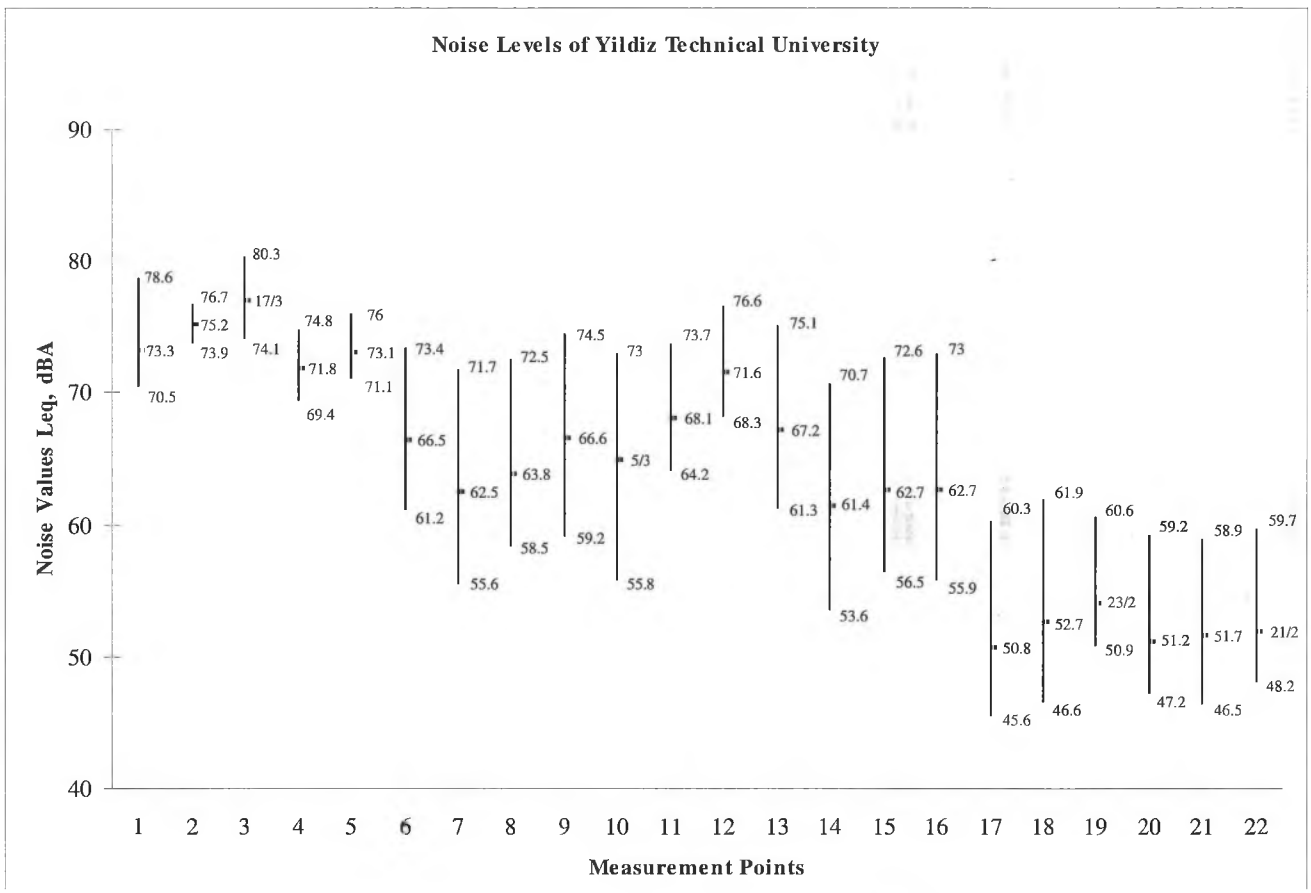

Figure 3. Max, min and average noise values of five months for each point.

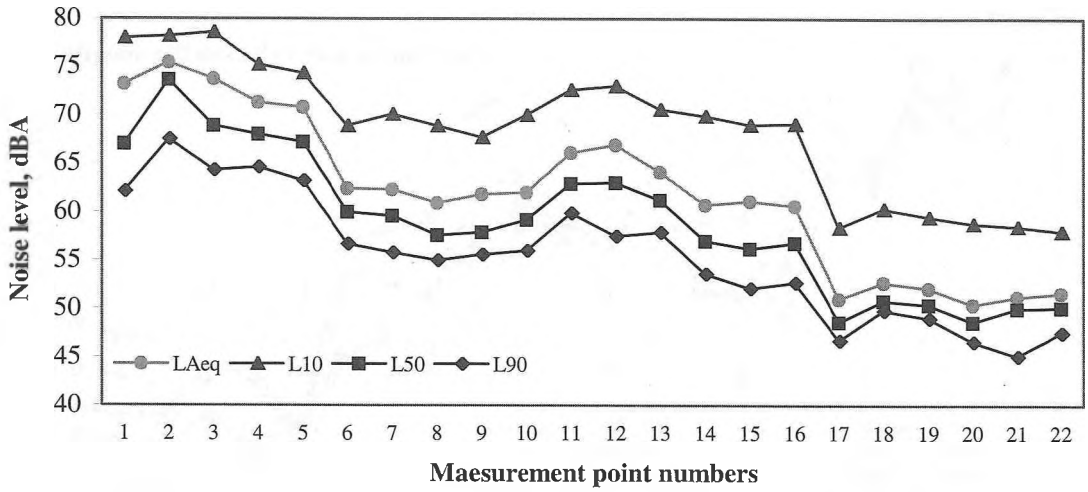

Figure 4a. Variation of statistical noise levels hourly in a day at 06.00-08.00 a.m

In order to reduce the high noise levels reaching the campus area, some control measures could be applied are summarised below:

1. Border wall height of the central campus should be increased.
2. Trees should be planted between Barbaros Boulevard and the central campus.
3. Dimensions of the windows at the boulevard side of the university can be made smaller.
4. Double windowpanes for these windows can be used.
5. In the central campus of the university, there is an open-air car park, which also causes a noise problem. To attenuate this noise cause, underground level-flatted parking lots inside of the campus should be constructed.

5 REFERENCES

1. Noise Control Regulation of Turkish Republic 1986
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3. Turkish Standards Institute, "Traffic Noise and the Measures for It's Prevention", Standard #10713, 1993.
4. Sargent,J.W., *et al.* "The disturbance caused to school teachers by noise", Journal of Sound and Vibration **70**(4), pg.557-572, 1980
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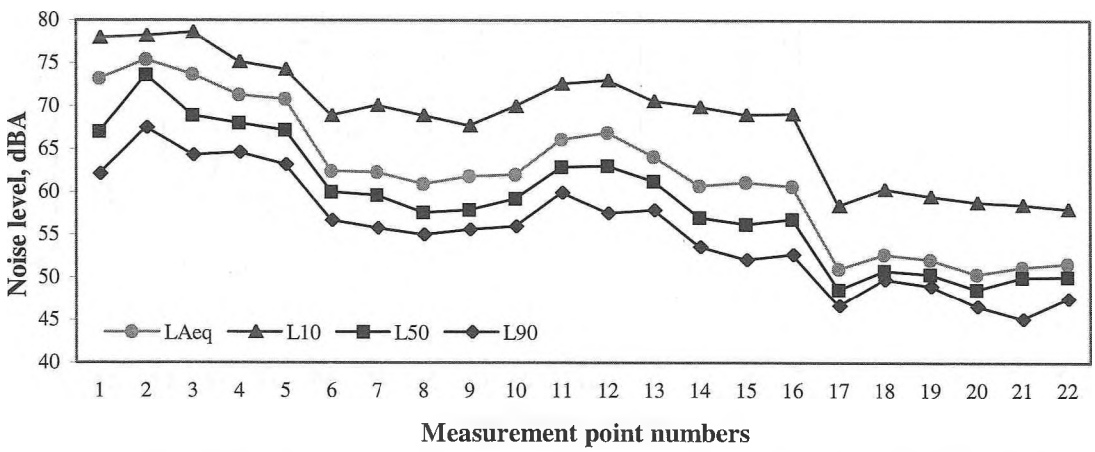


Figure 4b. Variation of statistical noise levels hourly in a day at 10.00-12.00 a.m

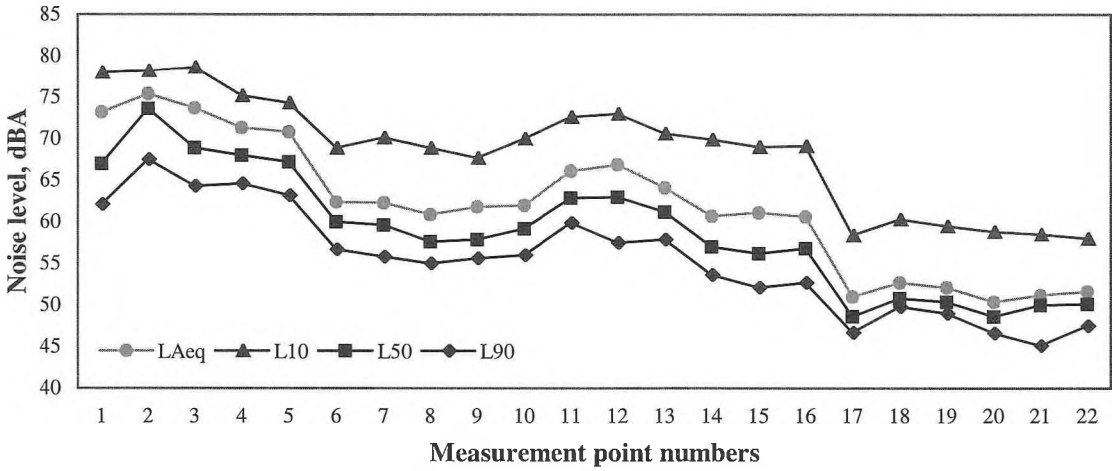


Figure 4c. Variation of statistical noise levels hourly in a day at 14.00-16.00 p.m.

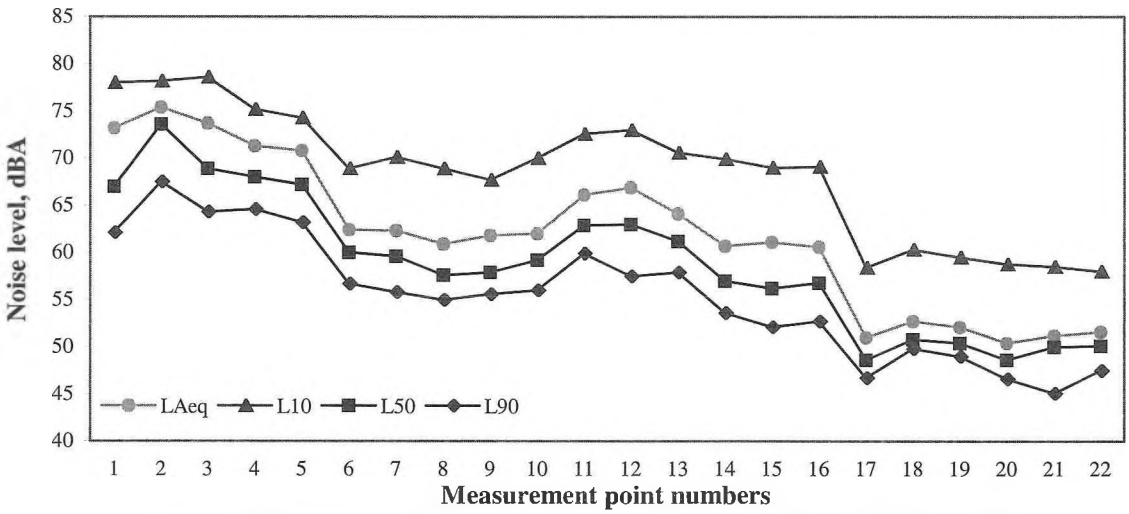


Figure 4d. Variation of statistical noise levels hourly in a day at 18.00-20.00 p.m.

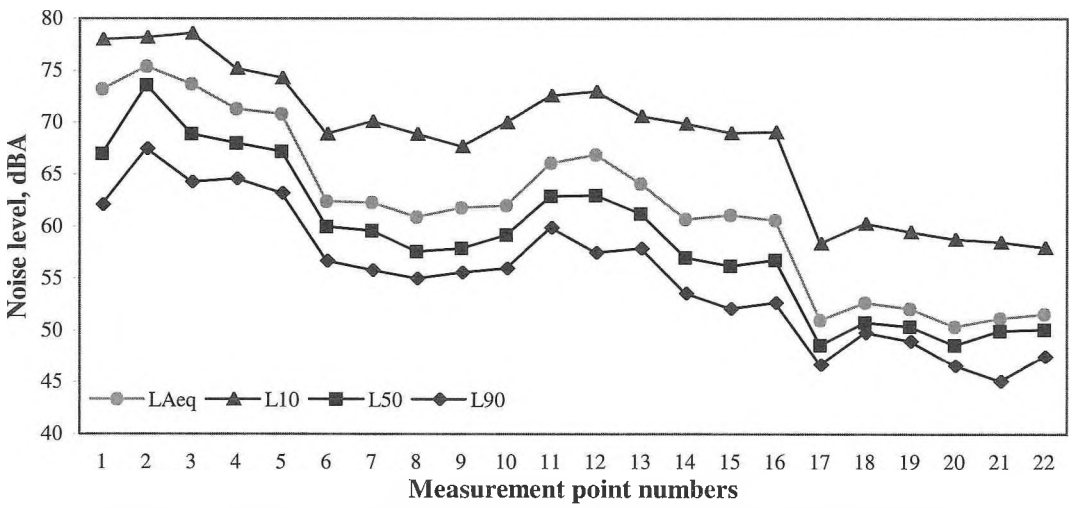


Figure 4e. Variation of statistical noise levels hourly in a day at 00.00-02.00 a.m.

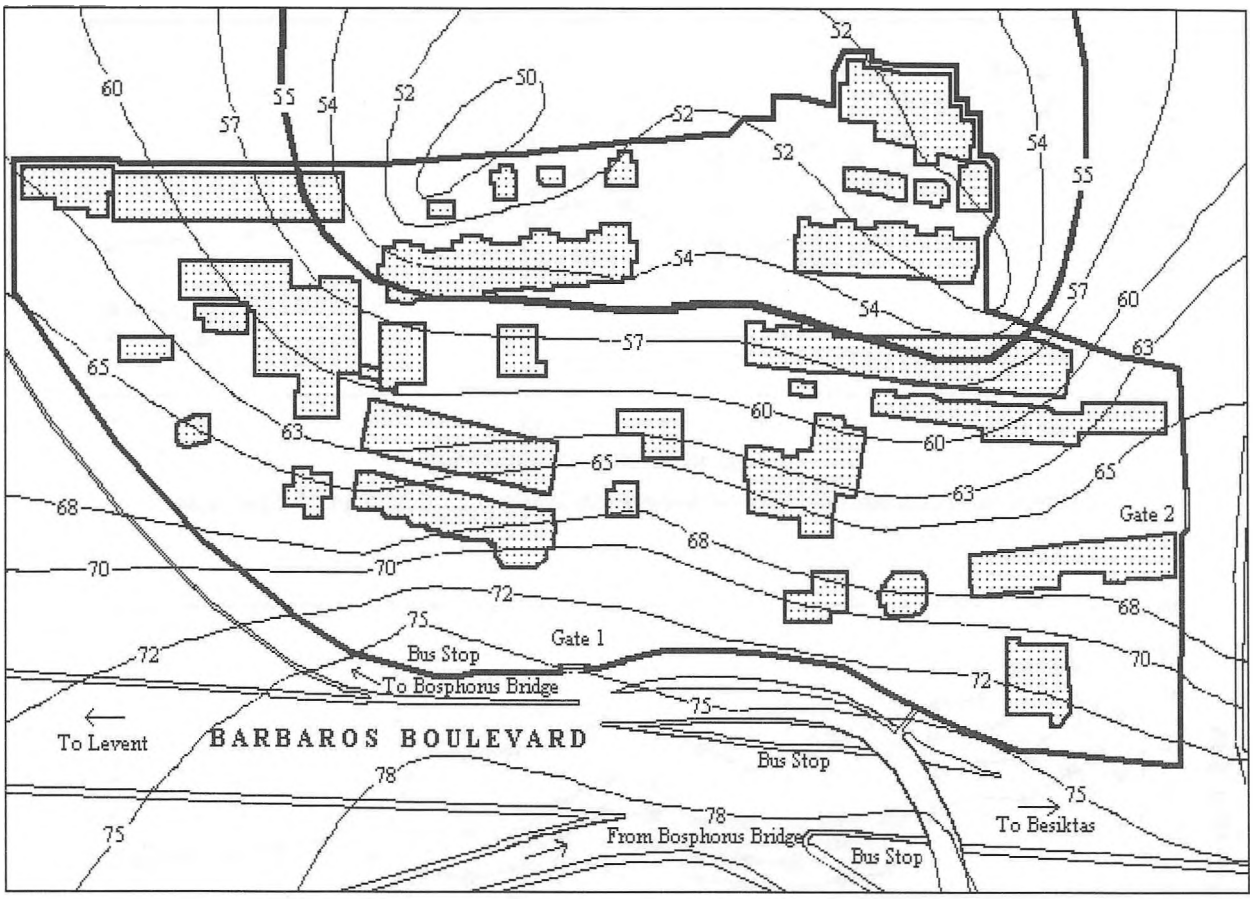
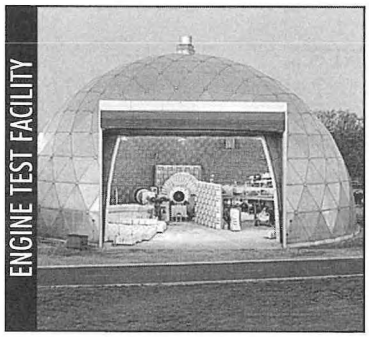
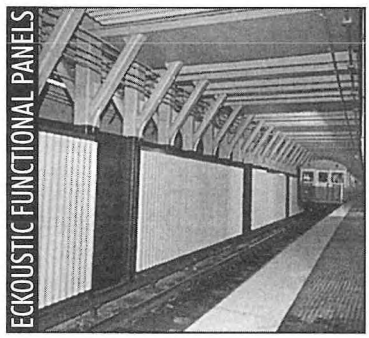


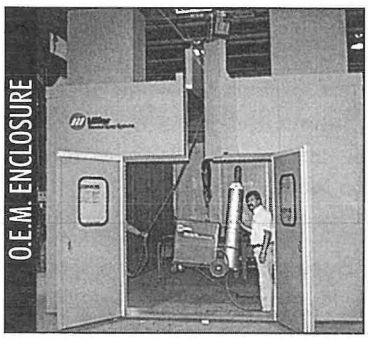
Figure 5. Noise contours map of the University.

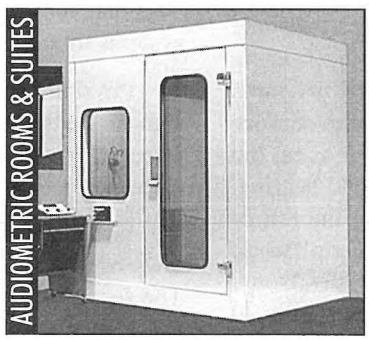
Table 2. Indoor noise values for sensitive places located front side of the campus

Location	Indoor noise values L_{Aeq}, dB	
	Windowpane closed	Windowpane opened
Classrooms		
Entrance flat	44	47.6
The first flat	45.3	49.5
The second flat	45.5	51.7
Other		
Kindergarten	44.7	50.3
Library	45.3	48.2









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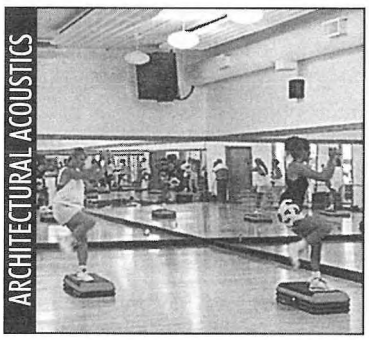

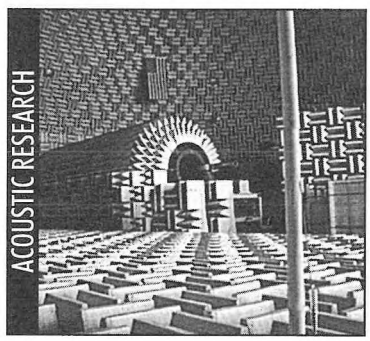

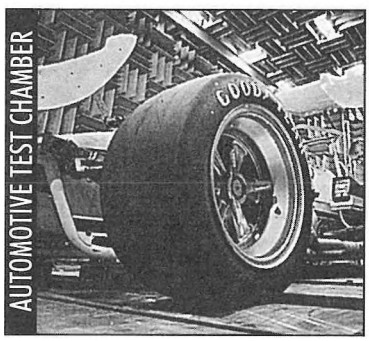

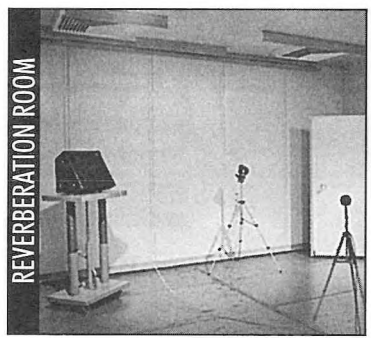

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