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ASSESSING AND MITIGATING NOISE POLLUTION IN ACADEMIC ENVIRONMENT AT THE AIR FORCE INSTITUTE OF TECHNOLOGY

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ABSTRACT

This study examines the impact of noise pollution within the Faculty of Sciences complex at the Air Force Institute of Technology (AFIT), a relatively young institution within military facility requiring necessary guidelines for safe living. The notable noise generators in this area are power generators and a concrete mixer. This research reveals that noise levels from the identified sources decrease with distance. The maximum sound level of 97 dB, 130 dB, 100 dB, 100 dB, and 150 dB was recorded for 3.5 kVA MAXMECH generator placed on an interlocking floor, 3.5 kVA MAXMECH generator placed on the ground, 4.5 kVA ELEPAQ, 9.5 kVA FIR-MAN, and the concrete mixer respectively. While at 50 m away for the respective machines, the minimum sound level recorded was 49 dB, 39 dB, 38 dB, 35 dB, and 68 dB. Moreover, the safe sound level of 75 dB was attained for the respective machines at a distance of 9 m, 6 m, 12 m, 10 m, and 16 m. Analysis indicates that the generators currently in use are positioned at safe distances from the building, but caution is advised against placing any within the faculty complex due to space constraints. The study underscores the importance of ongoing sound level assessments for all noise-generating equipment. Strategies such as sound absorbers are recommended for noise control. This research contributes valuable insights for maintaining optimal acoustic conditions and promoting a conducive environment for learning and productivity within academic institutions.

Keywords: Safe distance, AFIT, Generator, Concrete mixer, Sound meter

INTRODUCTION

Industrialization and modern technology have brought about an environmental challenge known as noise pollution (Özsever, 2019; Kpang and Dollah, 2021; Sarker *et al.,* 2023; Atih, 2021). Sound waves, which are perceived by the auditory nerves when acoustic pulses reach the ear, travel through the air, causing vibrations that can be detected by auditory nerves, leading to a sensation of hearing in humans and animals (Goshu et al., 2017). What one person considers acceptable sound might be considered noise by another. Over time, even initially pleasing sounds can become noise if they irritate (Alademomi et al., 2020; Isah *et al.*, 2024).

Uncontrolled noise poses risks such as occupational hearing loss, which has various negative effects including reduced quality of life due to social isolation and persistent tinnitus, impaired communication with family, coworkers, and the public, reduced ability to monitor the work environment, decreased productivity, and increased accidents, as well as expenses for worker's compensation and hearing aids (Natarajan *et al.,* 2023; Gadanya and Buhari 2021).

In any given location, multiple sources contribute to the overall noise level (McAlexander *et al.,* 2015; Park *et al.*, 2017; Ubiema *et al.,* 2021 Wekpe and Fiberesima 2020). For instance, when walking on a street and talking on a mobile phone, one may encounter traffic noise, conversations of passersby, and music from nearby establishments, all of which can interfere with communication. Similarly, within the Faculty of Sciences complex at the Air Force Institute of Technology where the primary business is the transfer of knowledge through lectures, seminars and workshops, there are several sources of noise including block molding machines, aircraft, vehicular movements, and conversations among occupants.

The Air Force Institute is within the Air Force Base Kaduna which in addition to other noise-generating activities like shooting, military parade, jogging with morale-boosting songs etc., has a busy air-field where both military and commercial aircrafts take-off and land. Flying practice and aircraft maintenance by airmen are major noise generating activities around the institution, especially when flying aircrafts like super Tucano, alpha jets and other high-decibel aircrafts.

The continuous expansion of the Air Force Institute of Technology culminating in increased activities cum use of generating sets to provide electricity in shops, lecture halls, laboratories, and offices are notable sources of noise generation on the campus are impacting the well-being of individuals if not properly managed. Therefore, it is crucial to evaluate the noise levels of notable noise generators around the building to ensure they fall within safe limits.

To properly assess the impact of these noise sources, this study aims to calibrate and analyze the sound levels of specific equipment including generators and a concrete mixer used in AFIT, to determine safe usage practices and mitigate potential health risks to personnel and students. The objectives include identifying the types of generators and a concrete mixer used in AFIT, calibrating their noise levels using sound meters, and conducting a comprehensive analysis to establish safe usage modalities. Understanding sound level dynamics within institutions is crucial not only for maintaining optimal acoustic conditions but also for addressing health, productivity, and quality of life concerns. This assessment provides the basis for implementing sound management strategies tailored to the institution's needs, fostering an environment conducive to learning, productivity, and well-being.

MATERIALS AND METHODS

Material

The primary material used in this research is a Sound Level Meter Model CA832 (a product of AEMC instruments). The instrument is designed to assess sound ambiances or nuisances in accordance with international safety and quality standards. It complies with standard IEC 651

(www.aemc.com). It is designed for simple, one-hand operation and may be fitted on a tripod for long duration measurements. It features two weighting curves A and C for measurement, integrating the sensitivity of the human ear according to sound frequency.
Other materials used in this study includes: measuring tape, to identify each point of observation, Excell package, for data processing and plotting.

Method
The variation of the noise level (dB) with distance from the equipment (3.5KVA MaxMech Generator, 4.5KVA Elepaq Generator, 9.5KVA Fir-Man Generator, and Concrete Mixer) is measured with the use of sound meter Model CA823, AEMC Instruments at 5m intervals. The instrument was held in the hand and the microphone directed towards the source of noise to be measured. The sound level was displayed, we pressed the MAX push-button to display the maximum sound level during the measurement.
In the course of measurement, the microphone was positioned far from any sound reflective surfaces such as ground, walls etc. to minimize errors due to possible interference. The meter was held at arm's length to avoid any reflections due the operator and to also enable free propagation of sound in all directions. The sound level instrument has three measuring range, we chose the high noise (80 to 130dB). When noise measurement is active, the measurement is repeated more than two times per second.
The CA832 uses filters, which weight or correct the measurement levels according to frequency. We adopted Curve A among the two correction curves available on the CA832, This is the most common weighting curve, corresponding to the "average international ear". It is usually used for the measurement of nuisance levels in industrial areas. Due to the difference in levels between the absence and the presence of noise being more than 10 db, the impact of background noise was not measured.

RESULTS AND DISCUSSION
Table 1 below shows the data collected within the area of interest. The data of sound level for each distance collected were plotted and the acceptable safe sound level, 75 db (Fink, 2017), was indicated for each sound generator around the faculty building (Figure 1 - 5)
The noise level of 3.5 kVA MAXMECH on a concrete (interlocking) floor decreases gradually as the distance from the generator increases (Figure 1). The maximum noise level of the generator is about 97 dB, while the minimum noise level at 50 m away from the generator is about 49 dB. The safe sound level of 75 dB intercepts the curve at a distance of about 9m. This implies that the 3.5 kVA MAXMECH generator may not be placed closer than 9m to the faculty building.
However, the distance from the center of the faculty building to the lecture rooms and offices is between 7m and 8m. Hence, it is not safe to place the generator within the faculty building when it is in operation.

Table 1: Noise calibration of various types of generators and a concrete mixer

S/N	MAXMECH (1) 3.5KVA		MAXMECH (2) 3.5KVA		ELEPAQ 4.5KVA		FIR-MAN 9.5KVA		CONCRETE MIXER	
	Distance (m)	Noise Level (dB)	Distance (m)	Noise Level (dB)	Distance (m)	Noise Level (dB)	Distance (m)	Noise Level (dB)	Distance (m)	Noise Level (dB)
1	0	88.9	0	110.5	0	90.2	0	88.9	0	102.4
2	5	75.9	5	85.7	5	87.3	5	81.3	5	90.2
3	10	72.5	10	79.1	10	76.7	10	75.1	10	81.5
4	15	69.5	15	75.5	15	69.5	15	68.5	15	75.5
5	20	67.3	20	69.4	20	65.5	20	56.2	20	64.3
6	25	61.5	25	65.3	25	59.7	25	52.4	25	72.6
7	30	59.3	30	55.0	30	55.6	30	48.3	30	71.5
8	35	56.0	35	50.3	35	50.0	35	42.5	35	74.2
9	40	52.5	40	45.5	40	43.5	40	38.6	40	70.5
10	45	49.7	45	39.3	45	38.5	45	33.7	45	68.7

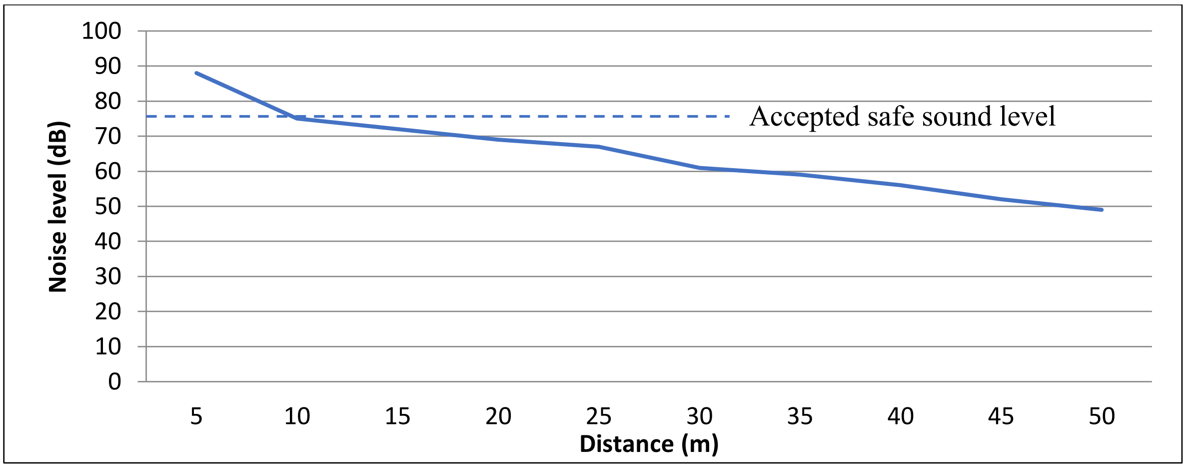

Figure 1: Noise level(dB) versus Distance(m) from 3.5 kVA MAXMECH Generator placed within the faculty of science building on interlocks

In the case of the 3.5 kVA MAXMECH placed directly on the ground, the noise level decreases rapidly as the distance from the generator increases (Figure 2). It can also be seen by extrapolating the curve that the maximum noise level of the generator is about 130 dB, while the minimum noise level at 50m away from the generator is about 39 dB. Finally, the safe sound level of 75 dB intercepts the curve at a distance of about 6m. This implies that the 3.5 kVA MAXMECH generator may not be placed closer than 6m outside the faculty building. However, the distance between from the generator and the faculty building is between 10 m to 12m. A fine-compacted material is a good sound proof (Mudashir, 2022). A good example, is an interlock, as shown in Figure 1 to have been characterized of a maximum sound level lower to that of the bare ground.

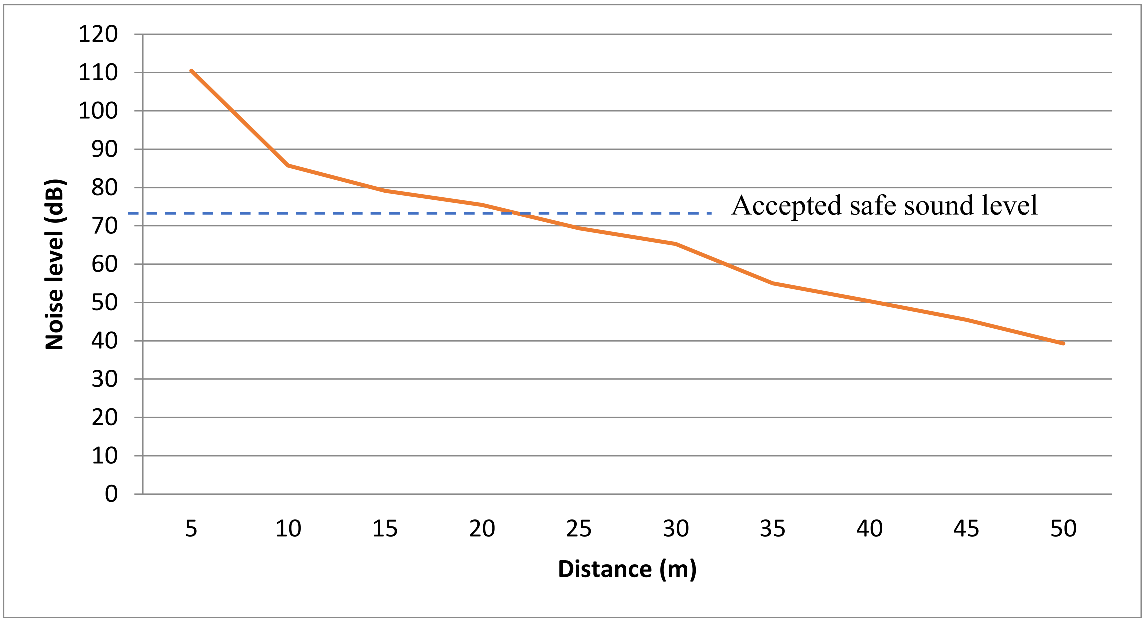

Figure 2: Noise level (dB) versus Distance (m) from 3.5 kVA MAXMECH Generator placed outside the faculty of science building on bare ground

The noise level of 4.5 kVA ELEPAQ generator decreases gradually as the distance from the generator increases (Figure 3). The maximum noise level of the generator is about 100 dB and the minimum noise level at 50m away from the generator is about 38 dB. The safe sound level of 75 dB intercepts the curve at a distance of about 12m. This implies that the 4.5KVA ELEPAQ generator may not be placed closer than 12 m from the faculty building, but the distance of the generator from the faculty building is about 25 m.

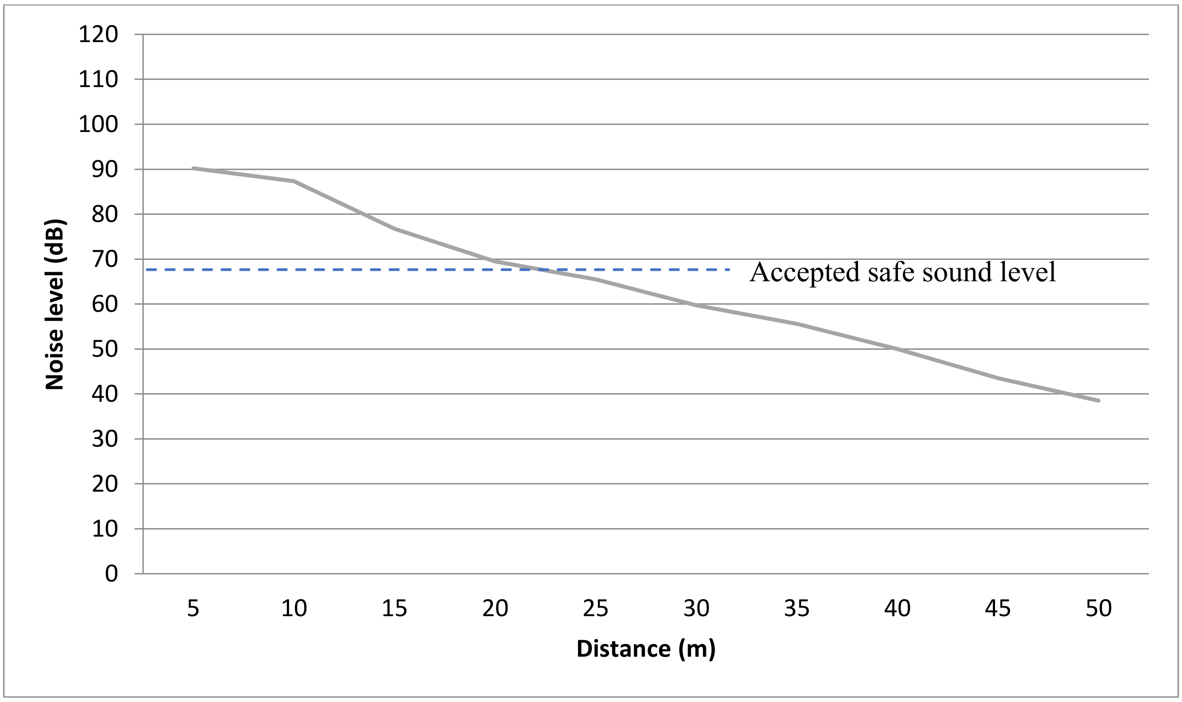

Figure 3: Noise level(dB) versus Distance(m) from 4.5 kVA ELEPAQ Generator

The noise level of a 9.5 kVA FIR-MAN generator decreases gradually as the distance from the generator increases (Figure 4). The maximum noise level of the generator is about 100 dB and the minimum noise level at 50 m away from the generator is about 35 dB. The safe sound level of 75 dB intercepts the curve at a distance of about 10 m. This implies that the 9.5 kVA FIR-MAN generator may not be placed closer than 10 m from the faculty building, but currently, the distance of the generator from the faculty building is about 9 m.

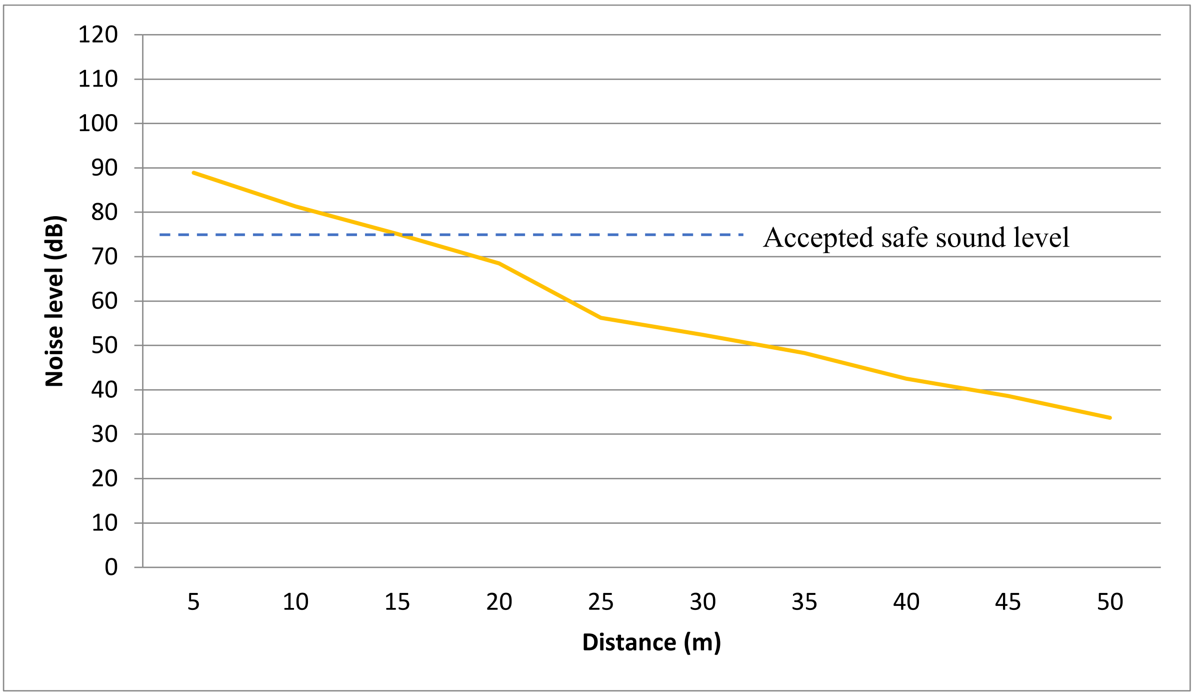

Figure 4: Noise level (dB) versus Distance (m) of a 9.5 kVA FIR-MAN generator

The noise level of the concrete mixer decreases gradually as the distance from the concrete mixer increases (Figure 5). The maximum noise level of the concrete mixer is about 150 dB and the minimum noise level at 50m away from the concrete mixer is about 68 dB. The safe sound level of 75 dB intercepts the curve at a distance of about 16 m. However, the mixer is about 100 m away from the faculty building where the effect cannot be felt. A single plot for all the noise generators is shown in Figure 6 and the primary observables are as shown in Table 2 below.

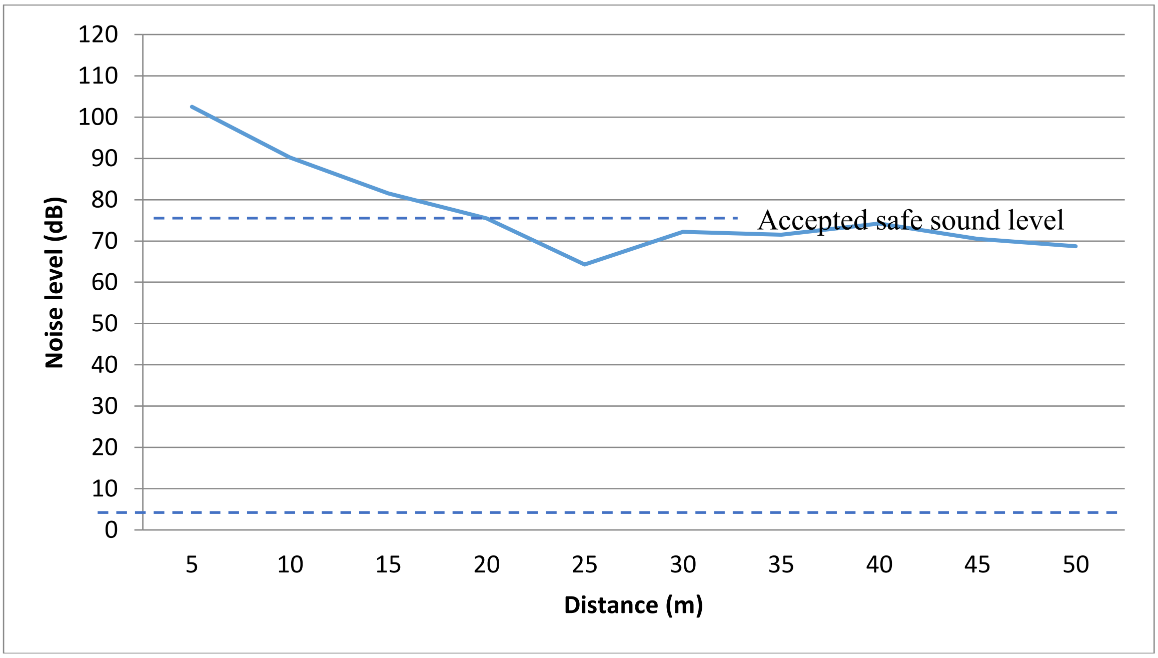

Figure 5: Noise level (dB) versus Distance (m) of a Concrete Mixer

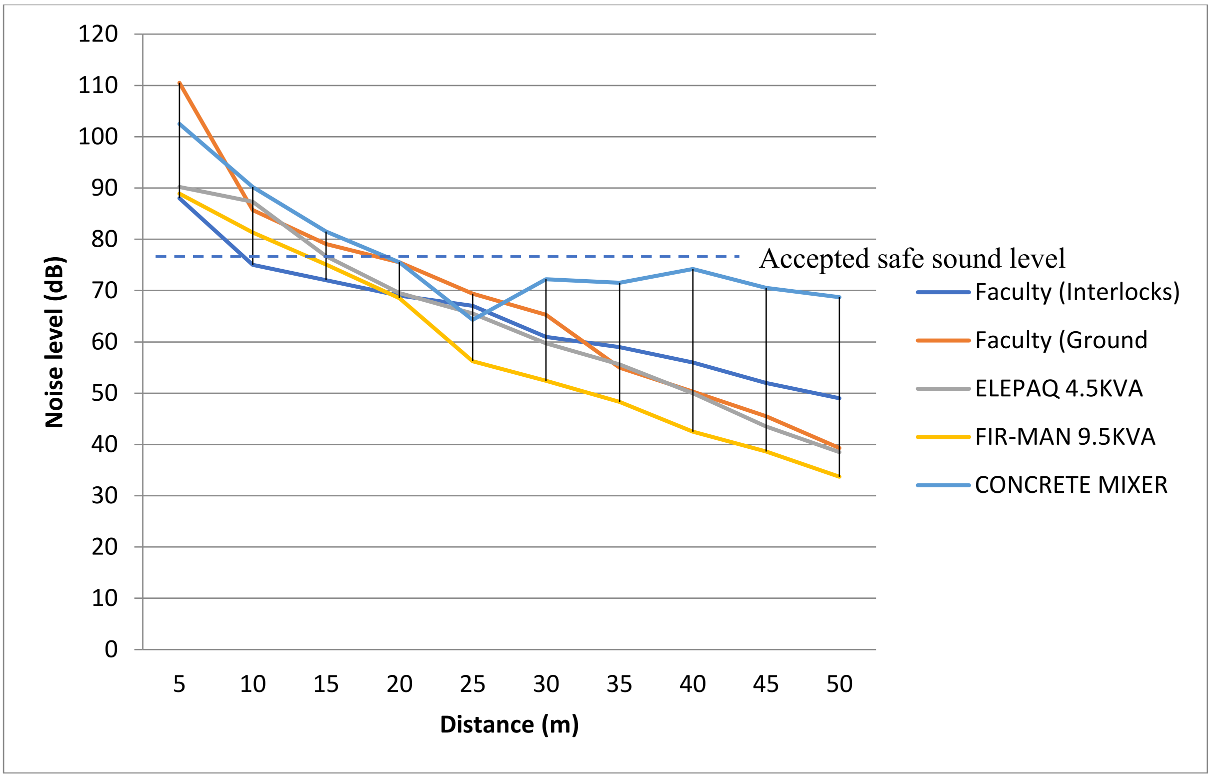

Figure 6: Noise level (dB) versus Distance (m) of three (3) generators and a concrete mixer.

Table 2: Summary of key observables

Equipment	Highest Noise level (dB)	Lowest Noise level (dB)	Distance of safe Noise level (m)
3.5KVA MaxMech Generator (On Interlocks)	88.0	49.0	9.0
3.5KVA MaxMech Generator (On Ground)	110.5	39.3	6.0
4.5KVA Elepaq Generator	90.5	38.5	12.0
9.5KVA Fir-man Generator	88.9	33.7	10.0
Concrete Mixer	102.5	68.7	16.0

CONCLUSION

The primary noise generators that are currently in use within the faculty building are at a distance above the safe use of the building. However, no noise generator within the class of the identified generators should be placed inside the Faculty building as the internal radius of the building is below the safe use distance, except the interlocking is removed as the earth is observed to be a good absorber of sound. A sound level analysis is however recommended for any noise-generating equipment later brought to the Faculty building.

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