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Field Report

Noise Effects of Generator Sets at Construction Sites

Abstract:

Noise and vibration can be the cause of serious disturbance and inconvenience to anyone exposed to them and in certain circumstances noise and vibration can be a serious hazard to health, causing permanent damage to hearing system. Noise exposure levels of construction workers are difficult to determine due to the day to-day variation in occupation and shift length of each worker and the itinerant and seasonal nature of the job. Nevertheless, it is clear that the construction worker is exposed to very high sound levels for considerable lengths of time.

Different types and sizes of equipment's, machineries and tools are used by construction industries. Diesel Generator for power is a very important one among the equipment used in the construction industries, used in large numbers and as clusters and also located very near to the work area. The noise level produced by these generators is much higher than the permissible limit. But the construction work group took very little effort to avoid or minimize this noise level to permissible level. Many people even though they may not need electricity for their work got in and exposed in this zone of danger. At this site eight generators have been used by various working groups.

This paper assesses the potential noise impacts associated with power generators used in construction activities of the DCT project site and the effective steps to control this noise. A 12-hour noise survey was conducted to establish background noise levels in the project area.

Key Words: Construction workers; noise; power generators; DCT.

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Introduction

Noise: "any loud, discordant or disagreeable sound." Noise intensity is measured in decibel units [1, 2]. The decibel scale is logarithmic; each 10-decibel increase represents at enfold increase in noise intensity [6]. Human perception of loudness also conforms to a logarithmic scale; a 10-decibel increase is perceived as roughly a doubling of loudness. Thus, 30 decibels is 10 times more intense than 20 decibels and sounds twice as loud; 40 decibels is 100 times more intense than 20 and sounds 4 times as loud; 80 decibels is 1 million times more intense than 20 and sounds 64 times as loud. Noise can cause hearing loss, lack of sleep, irritability, heartburn, indigestion, ulcers, high blood pressure, and possibly heart disease [3, 4]. Prolonged or frequent exposure to noise tends to make the physiological disturbances chronic. In addition, noise-induced stress creates severe stresses in daily living and contributes to mental illness.

Permissible Noise Exposure Levels

When the daily noise exposure is composed of two or more periods of noise exposure of different levels [5], their combined effect should be considered, rather than the individual effect of each. The permissible noise exposure levels with time [16] are given in Table I.

Table I Permissible Noise Exposures

Sound Level (dBA)	Permitted duration per work-day (hrs)	Sound Level (dBA)	Permitted duration per work-day (hrs)	Sound Level (dBA)	Permitted duration per work-day (hrs)
90	8.00	99	2.30	108	0.66
91	6.96	100	2.00	109	0.56
92	6.06	101	1.73	110	0.50
93	5.28	102	1.52	111	0.43
94	4.60	103	1.32	112	0.38
95	4.00	104	1.15	113	0.33
96	3.48	105	1.00	114	0.28
97	3.03	106	0.86	115	0.25
98	2.63	107	0.76	116	0.21

Equivalent Noise Exposure Factor

Noise levels are expressed in terms of the energy-equivalent continuous noise level, L_{eq}, which normalizes the L_{eq} to an 8

hour day. This could only be accomplished given a worker's pattern of exposure to noise; workers switch to different jobs/ tools/sites, and their shift length is variable and seasonal. Exposure to different levels for various periods of time shall be computed according to the formula [16].

$L_{eq} = (T_1 / L_1) + (T_2 / L_2) + ... + (T_n / L_n)$

where:

L_{eq} = The equivalent noise exposure factor.

T = The actual time of noise exposure by person at a constant noise level.

L = The duration of the permissible noise exposure at the constant level (from Table I).

If the value of L_{eq} exceeds unity (1) the exposure exceeds permissible levels.

Noise Exposure Levels (Daily L_{eq}) by Construction Activity

The DCT project construction will occur over a period of approximately 27 months. In various stages of construction we found a large variety of hand tools and other machinery contributing to a background level which is usually above 85 dBA [7]. Table.2 provides a list of trade, activity and equipment's that were used during project construction together with associated noise levels [8, 9, 17].

Table II Noise from construction equipment & Tools

Plant/Equipment	Noise (L_{eq}), dBA	Trade/Tools	Noise (L_{eq}), dBA
Dozers, Dumpers	89-103	Plumber	90
Front end load-ers	85-91	Elevator installer	96
Excavators	86-90	Rebar worker	95
Backhoes	79-89	Carpenter	90
Scrapers	84-102	Concrete form finisher	93
Mobile Cranes	97-102	Steel stud installer	96
Manlift	102-104	Laborers – shovel hardcore	94
Compressors	62-92	Laborers – concrete pour	97
Pavers	100-102	Hoist operator	100
Rollers (compactors)	79-93	Pneumatic chipper/ chisel	108
Bar Benders	94-96	Compactor	109
Pneumatic breakers	94-111	Electric drill	102
Hydraulic breakers	90-100	Air track drill	113
Pile drivers (diesel)	82-105	Concrete saw	90

Noise from Power Generators

Power Generators are essential for use on construction sites where electricity is not supplied. Power generators are used to power electric equipment, welding machines, for general and task lighting.

The workers involved in various works has exposed to various levels of noise by the machinery which they used [10, 18]. Apart from the noise by individual tool, the tools need electricity to work. In construction industries all the required electricity is supplied by the power generators, which also producing huge noise, the workers ultimately are exposed to double effect.

Project Site and Vicinity

The project extends to larger area whereas this study limited to exhibition hall only. The exhibition hall spread over 140 meter length (East to West) and 90 meter breadth (South to North) gives 12600 m2 area. The distance between the mega columns was 90 meters and the distance between two grid lines was 18 meters.

Ambient noise measurements were made for two generators at locations G1 & G2 as shown in Figure.1. This was done to measure the noise effect of individual generator. At the time the noise measurement equipment was set up, the sky was clear, temperatures were in the mid 22˚C, and the wind speed was light and variable. The measurement showed the noise exposure decreased with distance.

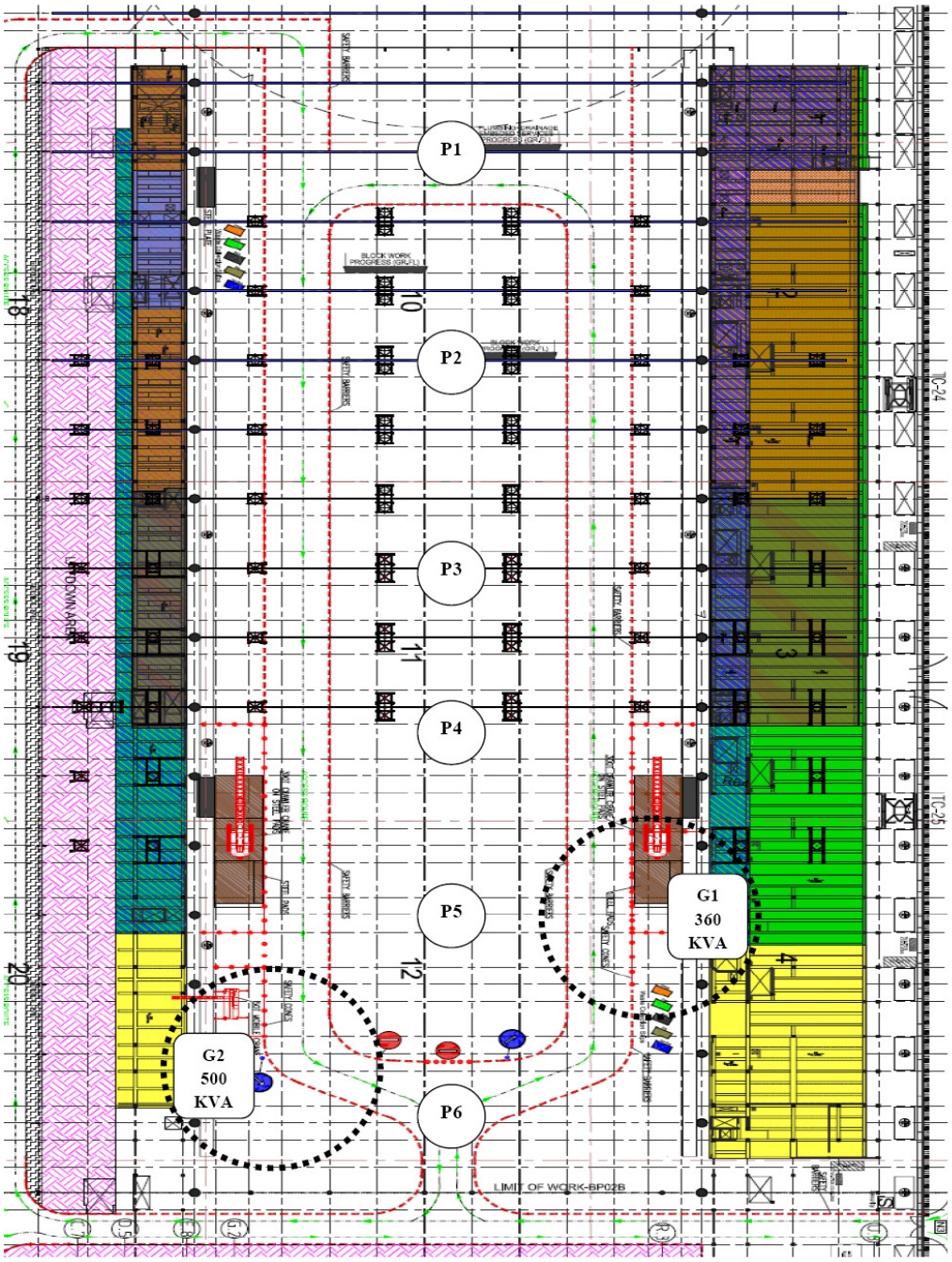
Actually the noise environment fluctuated greatly from hour to hour and location to location, depending on work activity within the exhibition hall. So another measurement was made at six locations during a normal working day over a period of 12 day. hours. Similar weather conditions were observed on the day when the measurement was taken down for exhibition hall. The measurement shows that the exhibition hall area is typically noisy throughout a normal working day.

Study Work

The usual sound sources of an electrical power generator are fan, bearing and sound radiation from the surface. In an electric generator the magnetic field produces the circumferential forces required for the energy transfer. In addition, the field creates radial forces. These forces interact with stator is in contact with the frame, which also is excited. The vibration of the frame accelerates the surrounding air, which is heard as noise [11]. To avoid excessive noise the designer of the generators needs calculate the vibration and noise levels [14]. In this work the noise emission of an electric generator used for power generation operations were studied.

The experimental readings were taken from two standard caterpillar diesel generators, one generator with 365KVA, 1500 rpm and 220V output (G1) placed at GL-15, Near to mega column in north side and the other with 500KVA, 1500 rpm and 220V output (G2) was located at GL-17, south side mega column No.17and placed 105 meter apart between them.

Figure 1. Location markings of Generators & Study points



The generators (G1 and G2) were not covered or provided with any acoustic shield; hence the entire noise generated will be transmitted to the environment. The exhibition hall was covered with building structure on north and south, covered with decking sheets and concrete on the roof. This makes the entire area to be considered as enclosed space. The noise generated by generators has to absorb and reflected and nothing will be transmitted, which increase the intensity of noise exposure by employees. All other activities in this area were stopped in order to eliminate the noise effect of other work activities. The noise level was observed on 21-02-2012 in a calibrated standard digital sound level meter with RS232 and noted from various distances. Table III presents the summary of noise levels measured at various distances from the source of noise, i.e. generators.

The noise levels from construction activities will vary during the different activity periods, depending upon the activity location and the number and types of equipment being used. Another set of readings were taken exactly the center point (i.e. 45 meter from each column) between the two mega columns of a grid line. Six points were identified or selected to cover the entire exhibition hall area with one point for every three grids. The study locations were marked in figure.3, the points P1 to P6 covered from gridline 3 to grid line 18(i.e. multiple of three). All construction activities in this area were continued in order to account the cumulative noise effect of other work activities. The readings were taken on 25-02-2012 for every one hour for a period of 12 hours (7 am to 7 pm). The measured values are tabulated in Table IV.

Table III Noise in dBA from Generator sets

Distance from the welding generator (m)	Noise Level, dBA		Distance from the welding generator (m)	Noise Level, dBA	
	Generator G1, 360 KVA	Generator G2, 500 KVA		Generator G1, 360 KVA	Generator G2, 500 KVA
	Max	Max			
1.0	103.7	104.3	11.0	87.6	89.3
2.0	100.0	101.3	12.0	87.4	88.3
3.0	97.6	99.6	13.0	87.1	87.4
4.0	94.9	95.8	14.0	86.0	86.4
5.0	92.5	94.3	15.0	85.1	85.6
6.0	91.2	93.5	16.0	84.6	85.1
7.0	89.7	91.9	17.0	82.7	83.6
8.0	89.4	90.6	18.0	81.3	83.2
9.0	88.7	90.2	19.0	80.2	82.6
10.0	87.7	90.1	20.0	79.9	81.8

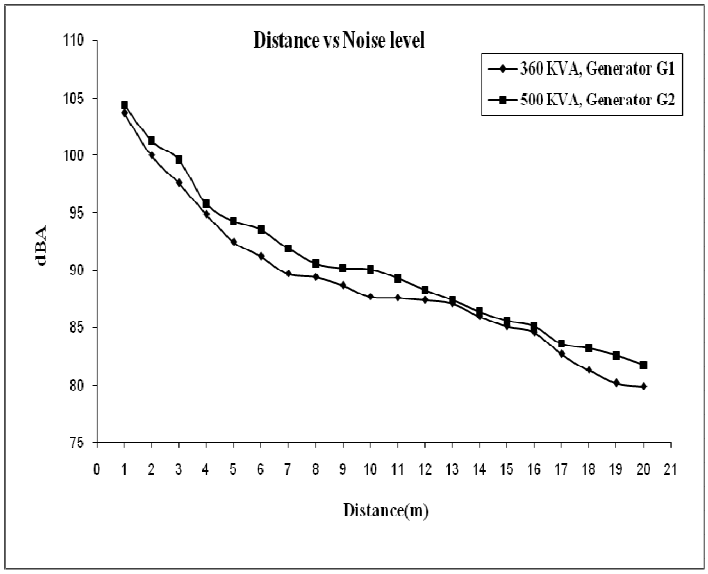
Table IV Cumulative Noise effects during working hours, dBA

Time (Hrs)	Noise Levels, dBA					
	Point, P1	Point, P2	Point, P3	Point, P4	Point, P5	Point, P6
7.00 am	85.4	79.3	78.6	85.7	82.4	89.1
8.00 am	86.5	78.9	77.8	86.8	83.5	92.5
9.00 am	81.3	80.6	78.0	83.2	80.5	88.1
10.00 am	80.5	79.7	78.9	83.5	82.6	89.5
11.00 am	79.8	79.4	81.8	83.0	81.1	85.2
12.00 Noon	77.8	78.6	80.9	82.4	80.9	85.7
1.00 pm	81.4	79.6	84.1	83.2	80.1	85.9
2.00 pm	81.1	80.2	83.7	83.0	82.3	86.1
3.00 pm	80.3	78.8	83.5	82.0	80.2	86.4
4.00 pm	81.5	80.0	82.9	84.4	81.5	85.8
5.00 pm	81.6	79.9	80.8	81.4	82.1	82.7
6.00 pm	80.6	79.5	80.3	82.7	81.1	82.8
7.00 pm	79.1	76.2	79.5	80.1	79.8	82.5

Result and Discussion

Based on the noise level observed from the generators, the noise level is higher than the permissible level, at 1.0 m from the generator; the values noted are 103.7 dBA and 104.4 dBA for G1 and G2 respectively. These values decreases with increase in distance and it reaches the permissible level of 90 dBA at 7.0m for G1 and 10.5m for G2 generators. Even though the permissible level is 90 dBA; hearing damage begins at a much lower level, about 85 decibels. This value is observed at 15m and 16m for G1 and G2 generators respectively. The effect of distance on noise is given in Figure.2

Figue.2. Effect of distance on noise level from generators



Construction noise would vary throughout the build-out of the Project according to specific activities, location, orientation of the activities, and changing equipment operations. To study the noise effects in the exhibition hall during a normal working day, a total of 78 noise measurements were made and data obtained were analyzed. Figure.3 presents a summary of graphical analysis of noise data. The overall average of noise level observed was 82.05 dBA which exceeds the threshold of 70 dBA. The measured noise levels increased with points nearby the generators. The maximum noise exposure noted was 92.5 dBA at point P6.

As shown in this graph, the majority of inhabited (community) receptor -related noise levels that would be from P4 to P6. For these locations, construction noise would be expected to be clearly audible during most of the daytime hours, depending on the actual, onsite construction activities. These points of perceptibility are not considered significant, however, based on the temporary nature of the construction phases and the intermittent duration of the worst-case activities. Other locations P2 and P3, would have construction-related noise levels, but below to any other location.

Mitigation Measures

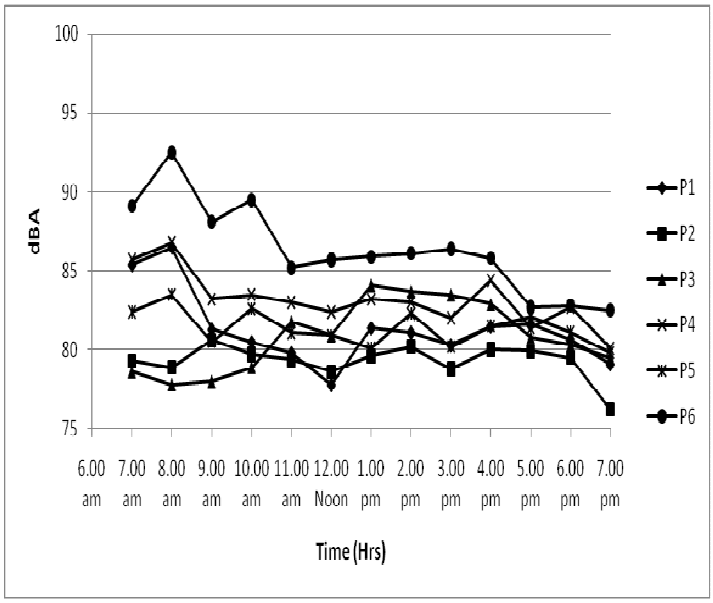
The cumulative noise impacts associated with the project were evaluated. The following mitigation measures will be implemented to reduce noise and ensure that Project noise impacts are less than significant.

- Locate noisy machines away from main areas of activity. Otherwise, screen plant from work areas by using noise

screens, berms or material stacked to form barriers [12].

- Fit silencers to combustion engines. Ensure they are in good condition and work effectively [13].
- Maintain machines regularly - they will be quieter

Figure.3. Graphical analysis of noise level at different locations in exhibition hall



- Keep machinery covers and panels closed and well fitted. Bolts/fasteners done up tightly avoid rattles
- During both construction and operation, post warning signs in high noise areas and implement hearing protection program for work areas where noise levels exceed 85 dBA [15].

Incorporate into the final design/procurement of Project facilities and equipment noise attenuation measures that ensure compliance with the legal requirements.

Table V Overall Noise Levels at Study Points Surveyed

Point	Noise Levels, dBA				
	Minimum	Maximum	Mean	Standard Deviation	Variance
P1	79.1	86.5	81.3	2.33	5.45
P2	76.2	80.6	79.28	1.08	1.17
P3	77.8	84.1	80.83	2.22	4.93
P4	80.1	86.8	83.18	1.73	2.99
P5	79.8	83.5	81.39	1.12	1.25
P6	82.5	92.5	86.33	2.90	8.45

Conclusion

Noise was measured at various distances from the generator equipment. In this site the workers are working without any ear protection at a distance of about 2m from the generators and are exposed to a minimum noise of 100dBA around 360 KVA generators and 101.3dBA around 500 KVA generators. The study shows the permissible level of noise (90 dBA) is reached at 7.0m for G1 and 10.5m for G2 generators. Noise from generators can be controlled by an increase in distance between the Generator and the worker or to introduce noise reduction screens or provide acoustic shield around.

So a hard barricading is needed at a minimum distance of 7m and this distance is further increased to 10.5m for 500 KVA generators, which provides protection and minimizes the workers exposure in noisy zone.

An overall mean equivalent noise level of 82.05 dBA was observed at 6 locations (78 measurements) in exhibition hall, which exceeds the threshold of 70 dBA that represents a cautionary risk of hearing damage of construction workers of about 400 involved in this work area. The exposure ranged from a minimum of 76.2 dBA to a maximum of 92.5 dBA.

This scenario might exists in any construction site wherever open generators are used for power generation. Hence during construction phase of any site needs to, investigate, document, evaluate, and attempt to take all feasible measures to reduce the noise at the source and implement hearing protection program for work areas where noise levels exceed 85 dBA.

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