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Studying the Noise Levels at an Electrical Power Station

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Abstract: Studying the noise levels has great significance by those whose concerned with the environment and human, because of its negative impact on human health and his performance. This paper presents a measuring of noise in the positions of the power station south of Baghdad includes 15 positions inside the station's building and 15 positions outside the station's building. The noise level measured in decibels by using the noise level meter (NLM). The results showed that the values of the noise level at positions outside the station's building are between (66.9dB – 88.1dB), which are for the positions of (p3-p15) are out of allowable levels according to the allowable limits for the WHO (67 dB), while the positions (p1 & p2) are within the allowable limits. The noise levels at positions inside the station's building (p1-p15) are (66.1dB –86.2dB) all the values are out of the allowable level for WHO (57 dB). To reduce the negative effects of noise, special materials should be used on the walls of the building to absorb the noise, as well as to minimize the exposing time to the noise in order to protect the workers' health.

Keywords: *Noise, NIHL, Decibel, Sound Pressure, Equivalent Noise Level.*

دراسة نسب الضوضاء في محطة الطاقة الكهربائية

الخلاصة: دراسة نسب الضوضاء لها أهمية كبيرة لدى المعنيين في مجال البيئة وصحة الانسان، وذلك لما له من تأثير سلبي على صحة الإنسان وبالتالي على جودة اداءه . يقدم هذا البحث دراسة نسب الضوضاء في محطة كهرباء جنوب بغداد بواقع 15 موقع داخل أبنية المحطة و15 موقع خارج أبنية المحطة. تم قياس مستوى شدة الضوضاء بوحدة الديسبل باستخدام جهاز قياس مستوى الضوضاء. بينت نتائج البحث الى إن قيم مستوى الضوضاء خارج أبنية المحطة كانت بين (66.9dB – 88.1dB) حيث تجاوزت قيم الضوضاء للمواقع (P3-P15) للحدود المسموحة من قبل منظمة الصحة العالمية (67 dB) بينما الموقعين (P1 و P2) فكانت ضمن الحدود المسموحة. قيم مستوى الضوضاء داخل أبنية المحطة للمواقع (P1-P15) فكانت (66.1dB-86.2dB) وجميعها خارج الحدود المسموح بها من قبل منظمة الصحة العالمية (dB57). لغرض تقليل التأثير السلبي للضوضاء يجب مراعاة استخدام مواد خاصة عند تصميم الجدران بحيث تعمل على تقليل وامتصاص الصوت بالإضافة الى مراعاة تقليل ساعات تعرض العاملين الى نسب الضوضاء حفاظاً على صحتهم.

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1. Introduction

The transformers of high power are fixed on electrical power plants, power transformers are classified according to their application: single-phase transformers and three-phase transformers, control transformers which may be with or without tuning [1].

The most important characteristics test of power transformer under voltage is noise level of, the main sources of noise are from the magnetic core of transformer, forced cooling systems, and coils, this noise is produced from fans, air cooling process, and pumps [2].The final operational characteristic test of transformer- noise level -, using standards "IEC 60076-10 (2001)" and "IEEE Std C57.12.90 (2006)". Testing values must confront the values of accepted noise level due to "NEMA - National Electrical Manufacturers Association Standards TR1 (1998)" [3].

accepted values of noise level of electrical power transformer are depending on, voltage test and cooling systems. When stress levels are increasing, then noise level is increasing. While for small distribution transformers which are up to 1000 kVA that were installed in distribution stations in civilized regions, the level of accepted noise is reach up to 64 dB. The national standards and European standards require stringent determinants for noise level according to the international standards [4].

The phenomena associated with the noise generation can be classified to:

-The material of a transformer produces magnetic properties. The vibration due to its magnetic strain varying at double the frequency of the magnetic flux.

- The gaps between plating of the transformer, the periodic motion force cause the plating to beating each other and generate noise.

- Pumps, and cooling fans in the electrical power transformer, are participate in producing noise [5].

2. Power Station of South of Baghdad

Power station of south of Baghdad Figure (1) composed of sixteen units equal amplitudes. Design capacity is (25 MW) per unit, the daily operating rate is (15 MW) per unit. The actual operation of the station began in May 2009. Two types of fuel used in the plant, the first one is the *heavy oil* (crude), the second one is the *gas oil* (Diesel). The amount of fuel used per unit about (90,000 - 130,000) liters per day of heavy oil and the same amount of gas oil. The station is located in the south of the city of Baghdad and surrounded by agricultural and residential areas.The aim of this study is to determine the reality of the noise pollution in south of Baghdad power station and then compare the results determinants with the WHO standards.

Figure 1. Power station of south of Baghdad.

3. Equivalent Continuous Noise Level (Leq.)

Equivalent Sound Level, or Leq, is the noise level that result in the total sound energy which produced at a given period of time, L_{eq} is defined as the average noise level during a noise measurement [6].

The sound level meter will automatically calculate the equivalent sound level during measuring and after the measurement has finished. Sound level meter will sample the noise level 16 times a second. It then converts the dB readings back into sound pressure levels, and adds them up, then divides by the number of samples and returns the L_{eq} back in the dB. All of this happens on an almost instantaneous basis [7].

Noise levels oscillate over a vast range with the time. The sound pressure level, equal to the sound energy over a specific period of time [8].

$$L_{eq.} = 10 \text{ x } \log_{10} \left(\sum_{1}^{n} 10^{Li/10} \right) \quad (1)$$

Where;

$L_{eq.}$ is the equivalent sound level

and;

L_i is the individual sound level

In an environmental measurements, the maximum magnitude of the exponential sound level is demand. It could be with any hesitation and time scaling, but perhaps the most mutual is the maximum magnitude of the hesitation and time scale sound level over the measuring period (L_{max}) [9]. Therefore, many people combine this up to the peak value (L_{pk}). This is simple to do, but they are very various actually. The Peak value is the biggest magnitude of the original vocal signal and for a sine wave, so the signal that produce from a sound calibrator, the peak value must be properly 3dB more than the sound level, or 2√2 times higher in pressure [10].

Peak sound pressure: Is defined as the highest absolute immediate sound pressure through announced time interval, it's measured by (Pascal) [11].

Peak sound level: Is defined as twenty times the logarithm to the basis ten of the proportion of a peak sound pressure to the indication sound pressure, peak sound pressure being acquired with a criterion hesitation, it's measured by (decibel) [12].

Max. sound level: Is defined as the biggest magnitude of the exponential sound level to the period and is commonly measured with a maximum withhold vocation. The symbol for the hesitation and time measurement is (L_{max}) [13].

For a sinusoidal sound the peak magnitude is 3dB more than the maximum level and this is the approaches they can bring to each other. For ‘natural’ environmental noise, the peak magnitude may be more than three hundred times (30dB) more than the maximum level [14].

Sound Level (Lp): is defined as a logarithmic magnitude of the root mean square of the sound pressure of a sound comparative to a indication value, the Threshold of Hearing. It's measured by decibels (dB) [15].

The indication sound pressure was selection traditionally to identify to the calming sound at 1000 Hz that the human ear can regulate Table (1) Shows some typical sound level.

Table 1. "Some typical sound level"[15].

Sources at 1 m	Sound Pressure		Lp (20 µPa)
Shooter	200	Pa	140dB
Threshold gaseous	20	Pa	120dB
Hammer of soreness	2	Pa	100dB
6 dB = double the Pa	1	Pa	94 dB
Road traffic	0.2	Pa	80 dB
Talking	0.02	Pa	60 dB
Library	0.002	Pa	40 dB
TV	0.0002	Pa	20 dB
Threshold of hearing	0.00002	Pa	0 dB

4. Noise-Induced Hearing Loss (NIHL)

"NIHL" can be happening immediately or may be happening after a long period of time. It can be permanent or temporary, and it can affect both ears or one ear, and can damaging hearing, you may have trouble hearing after a period of time, so the recipient is unable to hearing the people talk in a noisy room or on the phone. One thing which is very certain is: it is possible to prevent noise-induced hearing loss [16]. Noise pollution may cause harmful to health which may happen at any people age.

Unit of sound measurement is decibel (dB) it is the universal and is measured with a meter that records sound pressure and transfer these readings on a sound level scale. Decibels are a logarithmic unit, which is means if a noise measuring 30 decibels is in fact 10 times more than a noise recording at 20 decibels [17].

There is one challenge of measuring sound in the city is that: there is a high level of background noise, or ambient sound in an area [18].

If the sounds are less than 75 decibels, they are cause hearing loss even after long time of exposure. Therefore, any repeated exposure to the sounds or long time of exposure at or above 85 decibels level of sound may cause hearing loss. The more treble sound, even at shorter period of time "NIHL" may be happen [19].

5. Instruments

There are many types of instrument use to check the noise level:

1. Sound Level Meter (SLM) (Svan 955) from Polish Svantek Company.
2. Calibration device.
3. Microphone.
4. Amplifier.
5. Metallic stand.
6. GPS – Germen.

6."Sound level meter (SLM)"

To find the noise level, the "SLM – device" (Figure 2) is carried with hand at the height of the ear for those who exposed to the noise. With most SLMs devices it does not important where the direction of the microphone is in order to measure the sounds level [19]. It is very important to calibrate the device before and after each measurement.

Figure 2. (Sound Level Meter) SLM – device (svan 955)

7. Method

In order to study the noise level in power station at south of Baghdad, thirty positions were chosen in this study (fifteen points inside the station and fifteen points outside the station) as shows in Figure (3). The noise were measured in these positions Tables (2&3) shows the position, location, instantaneous peak, minimum and maximum value, sound energy level, equivalent level, and sound pressure level for each selected point.

For measuring the noise in the selected regions, according to the parameters of (ISO-1996) the following conditions should be applied:

1. Height of the microphone above the ground (120 cm).
2 The distance of the microphone from the noise source within (7 m).
3. Measurement period of the equivalent sound level (Leq) is (15 min) for each measuring test.
4. Cover the microphone to protect the effect of wind
5. The device record (L_{eq}.) as an equivalents number of (9000) readings.
6. The period of time between each two readings is (0.1 sec).

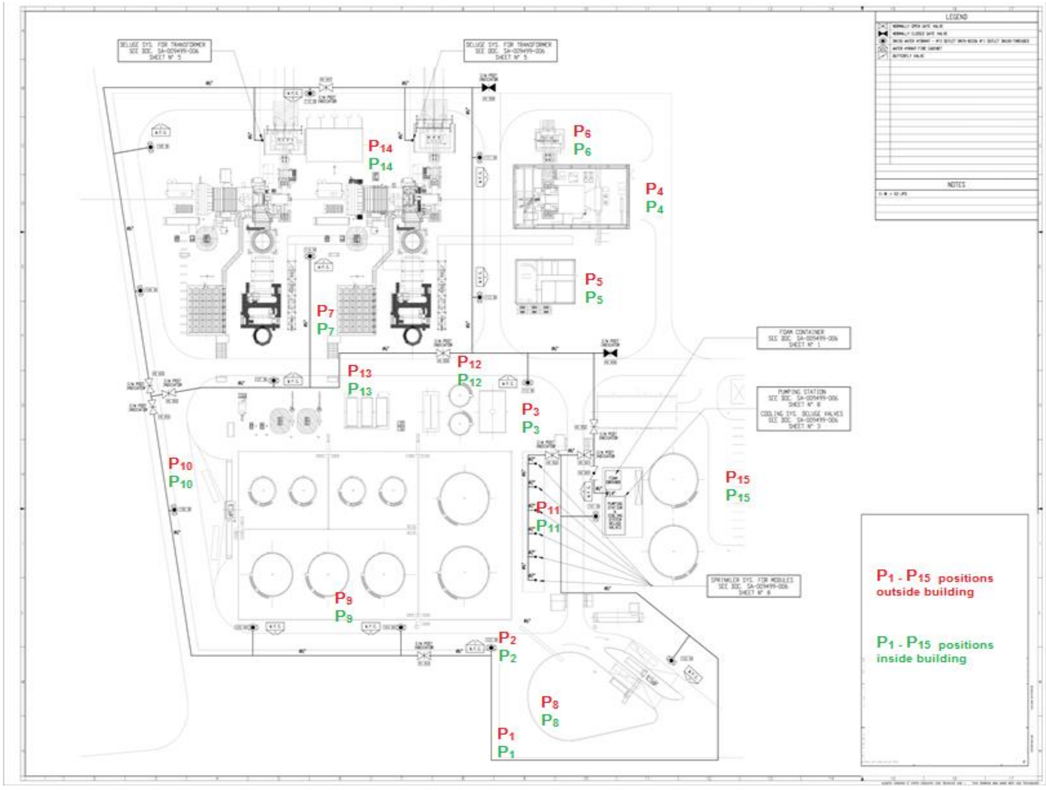

Figure 3. Map of the electrical power station explain the positions of the testing points.

8. Results and Discussion

From the results that have been obtained from the measurement, it was noted that the noise measurements has been divided into two main types:

- External noise (intended to the noise outside the building).
- Internal noise (intended to the noise inside the building).

The two types of the noise generally differ according to (WHO) standard in order to compare the noise pollution and find the values that exceed the allowable values.

The aim of this study is to be essential: -

1 - providing a database of actual values of noise inside and outside the station.

2 - to discuss the noise pollution at the power station, and compare it to the WHO allowable values.

Table (2) shows the positions of each points and the values of sound level measured by (SLM) for outside building in a power station, the Equivalent Level (Leq) ranged between 66.9 dB (at P2 near the Environment Laboratory) and 88.1 dB (at P14 near the transformer).

Maximum noise value is from 89.9 dB at (P2) (near the Environment Laboratory), up to 109.1 dB at (P14) (near the transformer).

Table 2. Values of sound level measured by (SLM) for outside building

Position	Instantaneous peak (dB)	Min. value (dB)	Max. value (dB)	Sound Energy level (dB)	Equivalent Level (dB)	sound pressure level (dB)
P1	103.1	63.1	92.1	98.91	67.1	69.1
P2	97.2	59.9	89.9	97.23	66.9	75.2
P3	113.1	71.4	97.3	104.89	77.3	78.1
P4	105.1	78.2	90.9	111.32	81.2	80.3
P5	108.4	72.3	95.1	108.14	79.1	79.4
P6	113.4	77.3	92.4	109.42	79.2	79.7
P7	122.1	83.5	98.4	115.16	85.2	85.1
P8	107.2	79.9	92.7	112.64	83.1	82.2
P9	103.9	82.2	93.3	114.27	84.2	85.4
P10	116.2	83.6	91.1	115.22	86.2	87.3
P11	104.1	81.1	91.5	114.07	83.2	83.4
P12	108.5	81.9	94.4	114.66	84.1	82.9
P13	125.6	82.8	95.3	115.12	85.2	84.8
P14	114.7	83.4	109.1	118.09	88.1	88.1
P15	121.8	76.1	95.9	112.31	82.3	79.9

More than 60% of external noise levels are exceed the WHO standard (67dB) as seen in Fig.(4) except (P1) and (P2). This indicates a serious noise pollution within the station limits, and that is also may affect the surrounding facilities.

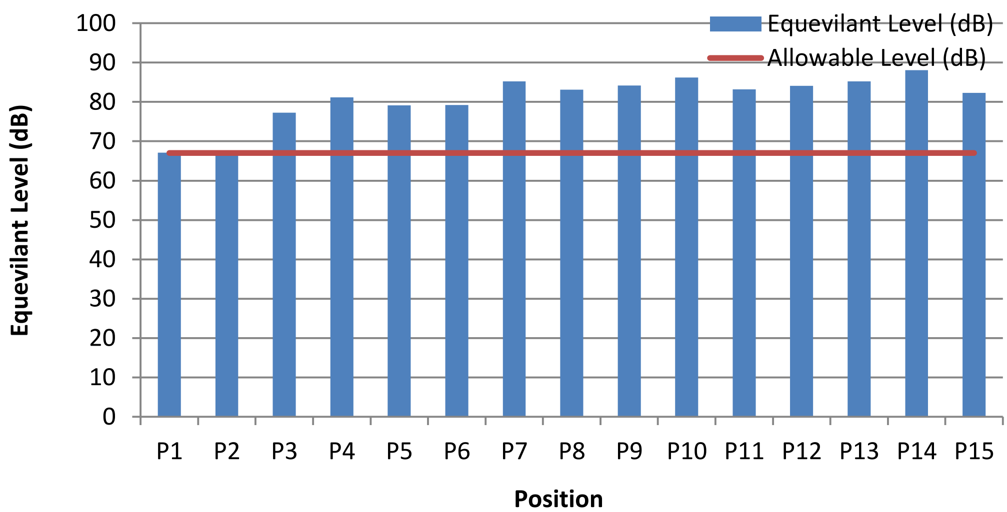

Figure 4. Equivalent level with position outside building

Table (3) shows the positions of each points and the values of sound level measured by (SLM) for inside building in a power station (halls and chambers), the Equivalent Level (Leq) values are between 66.1 dB at (P3) (in a control room) and 86.2 dB at (P11) (inside fuel reprocessing area).

Maximum noise value is from 96.8 dB (at P15 inside the office rooms) and up to 116.3 dB at (P10) (inside the maintenance workshop).

Table 3. Values of sound level measured by (SLM) for inside building

Position	Instantaneous peak (dB)	Min. value (dB)	Max. value (dB)	Sound Energy level (dB)	Equivalent Level (dB)	sound pressure level (dB)
P1	119.2	68.2	93.5	103.74	73.3	75.1
P2	121.3	65.3	93.2	101.81	72.4	71.8
P3	122.5	61.5	93.9	95.93	66.1	64.4
P4	113.1	74.1	98.6	108.91	78.9	79.6
P5	115.2	71.4	92.8	109.11	79.8	84.1
P6	98.1	64.6	87.7	102.16	72.3	70.2
P7	95.2	65.3	78.6	99.66	69.8	70.4
P8	122.2	68.8	98.8	102.77	73.1	71.1
P9	126.2	69.1	97.4	103.23	73.5	75.2
P10	132.1	68.3	116.3	112.62	83.1	70.8
P11	118.7	83.8	95.6	116.32	86.2	85.9
P12	103.2	68.2	92.1	107.54	77.9	78.5
P13	118.9	60.1	90.6	100.92	72.1	78.8
P14	112.4	65.6	93.2	104.33	74.3	71.8
P15	110.2	63.8	96.8	105.26	75.1	76.2

Note that all of the values are exceed the WHO standard (57dB) as seen in Fig. (5).

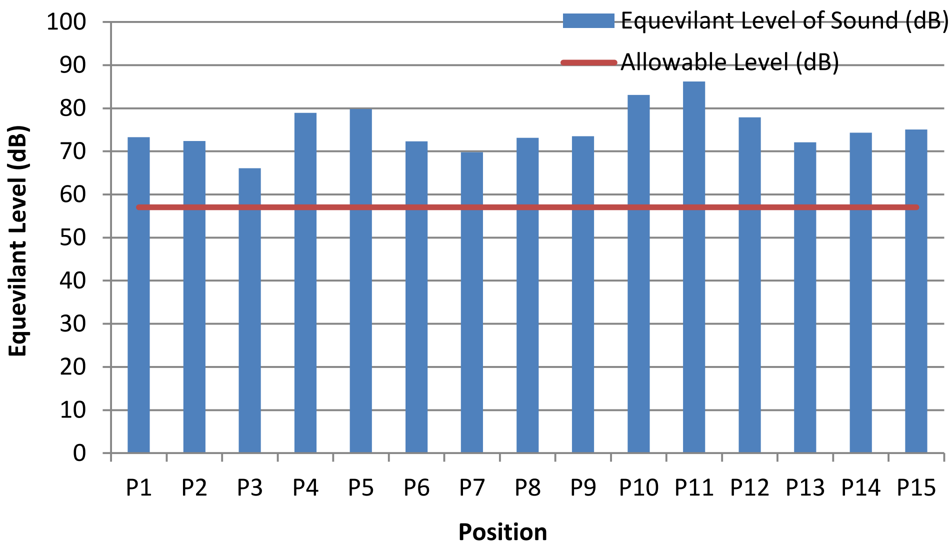

Figure 5. Equivalent level with position inside building

This shows there is no controlling on the noise to protect the workers and to reducing the noise level.

9. Conclusions

The main conclusions that can be drawn from this research were represented by the noise are produced from boilers, devices, and workshop inside and outside the power station.

There is a difference between the two positions in exposure of noise.
From the results all of the values in an inside positions are exceed the WHO standard (67dB) except (P1) and (P2) while all the values in outside positions are exceed the WHO standard (57dB).

In order to reduce the negative effects of noise, can be used the sound reflections from the walls and the possibility of the use of sound-absorbing materials inside the buildings.

10. References

1. Wolfe, J.(2014). *"What is acoustic impedance and why is it important"*. University of New South Wales, Dept. of Physics, Music Acoustics.
2. Lukic, L., Pejcic, N. (2011), "*A New Generation of Transformers with Wound Core Patented by ABS Minel Trafo Serbia*", Paper on call, Proc. 7th International Symposium Nikola Tesla, pp. 51-56, 23. November 2011, Belgrade.
3. Masti, R., Desmet, W., Heylen, W. (2004), " *The influence of core laminations upon power transformer noise*", Proceedings of ISMA, Vibro-Acoustic Modeling and Prediction, 3851- 3862.
4. Yanada, T., Mmowa, S., Ichinokura, O., Kuchi, S. (1998), "*Design and Analysis of Noise - Reduction Transformer Based on Equivalent Circuit*", EEE Transactions on Magnetics, pp.1351-1353, Vol.34, No4.
5. Thompson, A. and Taylor, B. N. sec 8.7. (2008). "Logarithmic quantities and units: level, neper, bel", Guide for the Use of the International System of Units (SI) 2008 Edition, NIST Special Publication 811, 2nd printing (November 2008).
6. William Hamby. (2010). *"Ultimate Sound Pressure Level Decibel Table"*. Archived from the original on 2010-07-27.
7. Müller, G., Möser, M. (2012). "*Handbook of Engineering Acoustics".* Springer. p. 7. ISBN 9783540694601.
8. Fredel S.C. (2000). "*Industrial Jet Noise"*. (in Portuguese). M.Sc. dissertation. Federal University of Santa Catarina, Florianópolis-SC-Brazil. 210 pages.
9. Graham J.B. (1992). "How to Estimate Fan Noise". Sound and Vibration. May, 24-27.
10. Hassibi A, Navid R, Dutton RW, Lee TH. (2004). "*Comprehensive study of noise processes in electrode electrolyte interfaces*". J Applied Physics. July;96(2):1074–1082.
11. Manwani A., Steinmetz P., Koch C. (2000). "*Channel noise in excitable neural membranes*". Advances in Neural Information Processing Systems 12. p. 142–149.
12. Pekkarinen and Starck, J. C. (2001). "*Industrial impulse noise*". Crest factors and the effects of ear muff. AIHA Journal.
13. Vaseghi S.V. (2006). "*Advanced Digital Signal Processing and Noise Reduction*". Wiley-Teubner.
14. Rohde U. L. and Poddar A. K. (2004), "*Noise analysis of Systems of Coupled Oscillators*". INMMIC workshop. Italy.
15. VDI 3767 (2007). "*Characteristic noise emission values of technical sound sources*". Machines for the forming of concrete blocks (bilingual German & English).

16. Samir N.Y. Gerges , Gustav A. Sehndt. (2002). "*Noise Sources: Noise and Vibration*". University of Santa Catarina.
17. Zawieska, W. (2007), "*A Power Transformer as a Source of Noise*", International Journal of Occupational Safety and Ergonomics (JOSE), pp. 381–389, Vol 13, No 4.
18. Rohde U. L., Poddar A. K., Schoepf J., Rebel R., and Patel P. (2005). "*Low Noise Low Cost Ultra Wideband N-Push VCO*". IEEE MTT-S, June.
19. Girgis,R., Garner, K., Bernesjo, M., Anger, J. (2008), " *Measuring No – Load and Load noise of Power Transformers using the Sound Pressure and Sound Intensity Methods*", Part I: Outdoors measurements, Scientific Conference "Power and Energy Society General Meeting", 20-24 July 2008, Pittsburgh.