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STUDY OF EFFECT OF NOISE PROBLEM AT THE POWER STATION OF ALZAWIH

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بسم الله الرحمن الرحيم

اللَّهُ نُورُ السَّمَاوَاتِ وَالْأَرْضِ مَثَلُ نُورِهِ كَمِشْكَاةٍ فِيهَا مِصْبَاحٌ الْمِصْبَاحُ فِي زُجَاجَةٍ الزُّجَاجَةُ كَأَنَّهَا كَوْكَبٌ دُرِّيٌّ يُوقَدُ مِن شَجَرَةٍ مُّبَارَكَةٍ زَيْتُونِةٍ لَّا شَرْقِيَّةٍ وَلَا غَرْبِيَّةٍ يَكَادُ زَيْتُهَا يُضِيءُ وَلَوْ لَمْ تَمْسَسْهُ نَارٌ نُّورٌ عَلَى نُورٍ يَهْدِي اللَّهُ لِنُورِهِ مَن يَشَاءُ وَيَضْرِبُ اللَّهُ الْأَمْثَالَ لِلنَّاسِ وَاللَّهُ بِكُلِّ شَيْءٍ عَلِيمٌ.

سورة النور (35).

In the Name of Allah, the Most Beneficent, the Most Merciful

Allah is the light of the heavens and the earth. The similitude of His light is as a niche wherein is a lamp is in a glass. The glass is as it were a shining star. (This lamp is) kindled from a blessed tree, an olive neither of the east nor of the west, whose oil would almost glow forth (of itself) though no fire touched it. Light upon light, Allah guideth unto His light whom He will. And Allah speaketh to mankind in allegories, for Allah is knower of all things.

An-Nur (35)

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ACRONYMS

Broadband :	Noise Measurements using parameters which include all the audible noise, such as dB (A) and dB (C).
Decibel (dB) :	The units of sound level and noise exposure measurement.
Leq :	Equivalent continuous sound pressure level. A measure of the average sound pressure level during a period of time, t in dB.
Peak :	The maximum value reached by the Sound pressure at any instant during a measurement period in dB usually with C frequency weighting.
SEL :	Sound Exposure Level .
SPL :	Sound Pressure Level, the basic measure of noise loudness, expressed in decibel.
OSAH:	Occupational Safety and Health Administration

الخلاصـــــــــــــة

تعرف الضوضاء علي إنها الصوت الضار والغير مرغوب فيه الذي يعكر صوفك والاستماع المفرط إلي الضوضاء يترك أثار جانبية علي الصحة مثل الإجهاد الشديد ، والزيادة في ضغط الدم ، زيادة معدل نبضات القلب بالإضافة إلي أرق عند النوم ، وتسبب فقدان السمع في معظم الأحيان، حالة الاستماع المفرط لساعات طويلة قد تؤدي إلي الوفاة .

تؤثر الضوضاء علي أداء العاملين في العديد من المواقع الصناعية ومن ضمن هذه المواقع محطات الكهرباء والتي سنتناولها في هذه الدراسة.

تدرس هده الأطروحة فيزياء الصوت (تتضمن الضوضاء) ، فسيولوجية الإذن ، كذلك المشاكل التي تسببها الضوضاء علي الصحة ، وطريق قياسها وكيفية السيطرة عليها، وتأثير الضوضاء علي العاملين في محطة كهرباء الزاوية أثناء الدوام اليومي المعتاد .

تم اختيار أكثر من 30 موقع للدراسة بداخل المحطة اعتمادا علي تعليمات إدارة المحطة من حيث أكثر المواقع التي يرتادها العاملين أثناء إجراء عملية الصيانة الروتينية واخذ القراءات بشكل دوري ، وكذلك المواقع المتوقع فيها تسجيل اعلي مستوي ضوضاء . وبعد إنهاء عملية القياس يتم مقارنة القياسات بمعايير السلامة الموصي بها من قبل إدارة الصحة والسلامة المهنية (OSAH) .

تحصلت الدراسة علي إن بعض المواقع مطابقة لمعايير السلامة الموصي به 8 ساعات في الدوام اليومي المعتاد. أما بعض المواقع لا تخضع لهذه المعايير.

ABSTRACT

Noise is an unwanted or damaging sound that may damage your hearing and cause other health effects such as stress, hypersensitivity to noise, increased blood pressure, increased heart rate and cause death. Due to the effects of noise to the performance of working people at many industrial locations. such as power stations.

This thesis have reviewed the physics of sound (include noise), method of controlling, methods of sound measurement in the literature and its effect to the worker during one shift at Al zawih electric power stations (Libya). The case study have selected more than 30 locations according to the management of power station, which expected to have high level of sound pressure during the operations and maintenances. The experimental work have done by the appropriate equipment recommended by Occupational Safety and Health Administration (OSHA).

The results of the study have shown that many locations are not permitted to workers for 8 hr shift , others shown are safe to work .

Chapter 1

1.1 INTRODUCTION

The noise is difficult to defined ,One person's music is another person's noise. Sounds that are soothing for some are irritating to others. People who study sound define noise as complex sound waves with irregular vibrations and no definite pitch .In engineering , Noise is defined as a sound signal that interferes with the detection or quality of another sound signal. And still others define noise simply as unwanted sound.[1]

Noise is one of the most common pollutants. It is often ignored because it is Colorless, Odorless, and tasteless . And yet it can have negative effects on human well-being. Is music noise? Is highway traffic noise? Maybe early morning construction falls within your definition of noise. Or do you find lawn mowers and leaf blowers to be noise?.[2]

Whatever you define as noise, it can affect your hearing. Listening to loud noise for long periods of time can cause. A permanent hearing loss by disrupting the delicate hearing system. This is called noise-induced hearing loss (NIHL).[2]

The sequence of the sound movement in the following way: The loud sound is collected by the ear as sound waves. The sound travels down the ear canal to the eardrum. The loud sound passes through the middle ear into the inner ear, also known as the cochlea. The tiny hair cells. Lining the fluid-filled cochlea can be damaged by loud sound.

Only healthy hair cells can send complete electric signals to the brain for interpretation and understanding. If the hair cells are damaged by loud noise, the signals cannot be correctly interpreted by the brain. Based in that, is decided to study the noise effect in Alzawih power station [2].

1.2 DEFINITION OF NOISE

Noise is an unwanted or damaging sound that may damage your hearing and cause other health effects such as stress, hypersensitivity to noise, increased blood pressure and increased heart rate. It can also interfere with communication at work, which could lead to accidents. The normal range of hearing for a healthy young person is from approximately 20 Hz (Hertz) to 20,000 Hz (20 kHz). Our ears are more sensitive to the middle frequencies, which range from 500 Hz to 4000 Hz - the speech frequencies. Hertz is a measure of the pitch or frequency of sound. [3]

Noise is present in every human activity, and when assessing its impact on human well-being it is usually classified either as occupational noise (i.e. noise in the workplace), or as environmental noise, which includes noise in all other settings, whether at the community, residential, or domestic level (e.g. traffic, playgrounds, sports, music).This study concerns only occupational noise; the health effects of environmental noise are not considered in this study. [4]

Noise varies from nuisance noise to loud industrial noise. It can be continuous or intermittent. Both types can be damaging to the human ear depending on the level of noise and the length of time someone is exposed to it [5]

Physically, there is no difference between sound and noise. Sound is a sensory perception and noise corresponds to undesired sound. By extension, noise is any unwarranted disturbance within a useful frequency band by National Institute for Occupational Safety and Health (NIOSH).[5]

Sound is mechanical energy transmitted by pressure waves in a compressible medium such as air. Sound is characterized by various parameters that include the rate of oscillation of sound waves (frequency), the speed of propagation, and the pressure level or energy content (amplitude). In particular, the sound pressure level has become the most common descriptor used to characterize the loudness of an ambient sound level. This may be because the sound has undesirable characteristics like pure tones (whines, hums, squeals), or impulsive components (hammering, shooting, barking dogs) or is continually coming on and off so that it is very difficult to "tune it out". Perhaps it interferes with important activities like sleep, relaxation, conversation or listening to music, TV, radio or natural sounds. The sound may have unpleasant associations for the listener, create fear, convey unwanted information or result from an activity that is considered destructive or pointless but is outside the listener's control. Therefore, while the tree that falls in a deserted forest clearly creates sound, it does not create noise, since there is no one to hear the crash and judge it to be noisy.[6]

Noise is widely recognized as a form of environmental pollution. However, there is a significant difference between noise and others familiar forms of pollution such as that of air and water. There may be some disagreement over what levels of air or water pollution are truly harmful but there is general agreement that air and water pollution are not "good things" and that the world would be better off without them.[6]

1.3 TYPE OF NOISE

1.3.1 Continuous noise

Continuous noise is produced by machinery that operates without interruption in some mode, for example, blowers, pumps and processing equipment.

1.3.2 Intermittent noise

When machinery operates in cycles, or when single vehicles or aero planes pass by, the noise level increases and decreases rapidly. For each cycle of machinery noise source, the noise level can be measured just as for continuous noise.

1.3.3 Impulsive noise

The noise from impacts or explosion, e.g., from a pile driver, punch press or gunshot, is called impulsive noise.

1.3.4 Tones in noise

Annoying tones are created in two ways: machinery rotating parts such as motors, gearboxes, fans and pumps often create tones. Unbalance or repeated impacts cause vibration that, transmitted through surfaces into the air, can be heard as tones. Pulsating flows of liquids or gases can also create tones, caused by combustion processes or flow restrictions.[7]

1.3.5 Low frequency noise

Low frequency noise has significant acoustic energy in the frequency range 8 to 100 Hz. Noise of this kind is typical for large diesel engines in trains, ships, and power plants and, since the noise is hard to muffle and spreads easily in all directions, it can be heard for miles.[7]

1.4 NOISE PROBLEMS

Noise has been linked to obvious ailments such as hearing loss, but also affects productivity and concentration in workers, creates unnecessary stress among all users, and impinges on leisure and recreation around your family. And to solve this problem of noise, must be understand all maintenance worker and operation worker this problem and start to choose the better management of noise in the workplace.[8]

1.5 RESEARCH METHODOLOGY

1) Define the work place in the plant cause noise .
2) Choose the plant of the study (Alzawih-power stations).
3) Define the work station where possible sound may become noisy.
4) Select the measurement equipments recommended by Occupational Safety and Health Administration OSAH and calibrated it.
5) Select the period of the study.
6) Collect the measurement data by using an appropriated devices.
7) Analyse the data according to the standard by Occupational Safety and Health Administration OSAH standards.
8) Draw the results, conclusion and the recommendation

1.6 OBJECTIVS OF THE THESIS

The objective of the thesis as following :

1) Review of the literature of industrial safety and specially in noise problems.
2) Study the effect of the noise at the power station.
3) Measurement of the noise by using the noise measurement instrument at various location around the station and estimate the noise level.
4) Evaluate the noise for selected period with respect to standard safe time for the worker on the station and other similar stations in Libya and set the safe noise level.

1.7 IMPORTANCE OF RESEARCH

1) To provide safety and health from noise sources, the worker exposed during the working time period in electrical power stations.
2) To educate workers in industry about the safety engineering concept (noise).

1.8 ORGANIZATION OF THE THESIS

Chapter one is an introduction about the noise definition, sources, control and health effect has been addressed as well as the objectives of the thesis are presented.

Chapter two is a review of the literature of industrial safety and specially in physics of noise (sound),physics of ear, noise damage, measurement devices and calibration dosimeter by calibrator device .

Chapter three represents the case of study which was Al zawih power station. Selection of location points and the measurement reading was taken in five days.

Chapter four, studying the analysis reading by take an average in five days reading at all location points, discussion and results.

Chapter five is the Conclusion and Recommendations.

Chapter 2

REVIEW OF LITERATURE

2.1 Physics of noise (sound)

As sound energy travels through the air, it creates a sound wave that exerts pressure on receivers such as an ear drum or microphone. Sound pressure is typically measured in micro Pascal (μPa) and converted to a sound pressure level in decibels (dB) for reporting purposes. The decibel scale is a logarithmic scale relative to the human threshold of hearing. Sound pressure level is used to determine loudness, noise exposure, and hazard assessment .

Physically, there is no difference between sound and noise. Sound is a sensory perception and noise corresponds to undesired sound. By extension, noise is any unwarranted disturbance within a useful frequency band. Noise is present in every human activity, and when assessing its impact on human well-being it is usually classified either as occupational noise.[9]

2.2 PROBERTIES OF SOUND

To defined the sound or noise in today's, we need to know a little about its fundamental properties such as Frequency (pitch), Wavelength, and Amplitude (loudness). Once these fundamental properties of sound or sound waves are understood, we can proceed to implement effective noise control measures.

2.2 .1 Frequency (pitch)

Sound is a form of mechanical energy transmitted by vibration of the molecules of whatever medium the sound is passing through. The speed of sound in air is approximately 1,130 feet per second. In steel it is approximately 16,360 feet per second and 4,900 feet per second in water. The denser the medium, the faster sound travels in that medium.

A pure sound wave of a single frequency takes the shape of a sine wave as shown in Fig (2.1). The number of cycles per second made by a sound wave is termed its frequency. Frequency is expressed in Hertz (Hz). The sound we hear is usually radiated in all directions from a vibrating medium.[10]

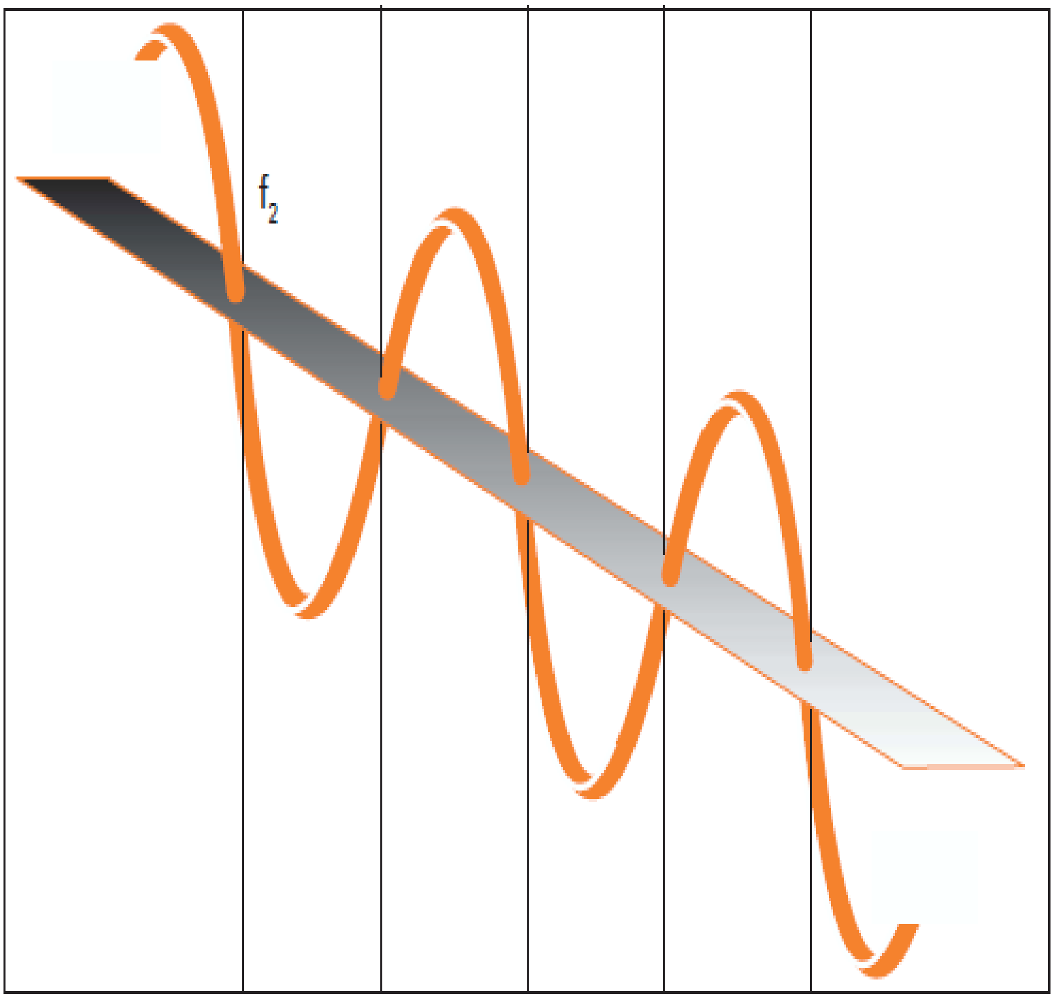


Figure 2.1 Pure sound wave, as from a tuning fork [10]

.

Most of the sounds we hear, however, are a combination of many different frequencies shown Fig (2.2).

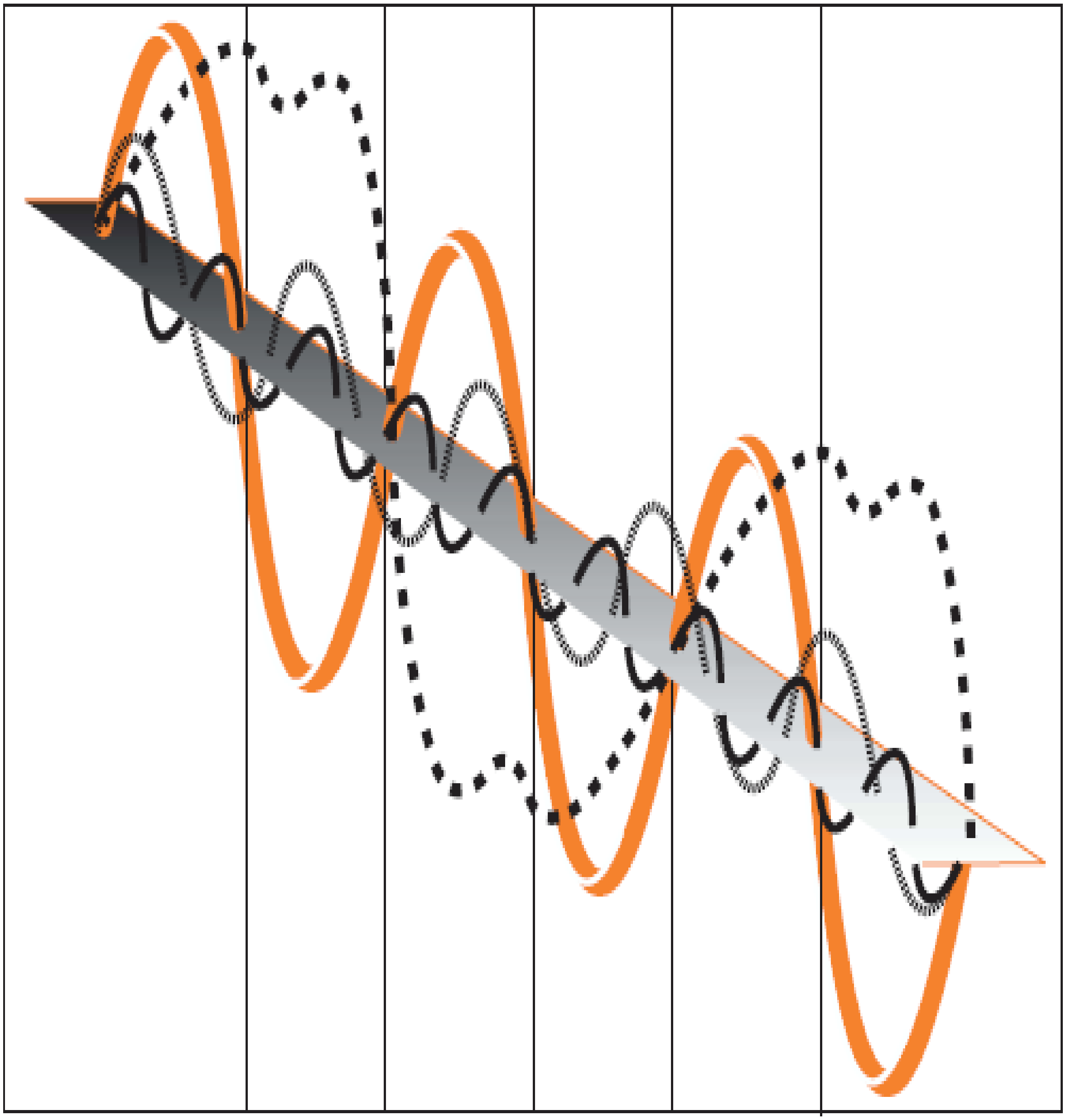


Figure 2.2 Most sounds we hear are more complex [10]

Healthy young human beings normally hear frequencies as low as about 20 Hz and as high as 20,000 Hz. At middle age this range decreases to about 70 to 14,000 Hz.

By comparison, the frequency range of a piano keyboard is from 31.5 Hz to 8,000 Hz. Because human hearing is most acute to frequencies in the region of 4000 Hz, we hear a 4000 Hz tone as being louder than a tone at some other frequency, even though the acoustical energy, or sound power, may be the same. For purposes of noise control, acousticians divide the audible sound spectrum into octaves, just as the piano keyboard does. These divisions are expressed as octave bands and are referred to by their center frequencies. Each center frequency is twice that of the one before it. When a more detailed sound spectrum is required, octave bands are further divided into thirds Table 2.1. [10]

(Table 2.1). Octave band and band limits [10]

Octave band center	
frequencies, Hz	Band Limits
32	22-45
63	45-89
125	89-178
250	178-355
500	354-709
1000	707-1414
2000	1411-2822
4000	2815-5630
8000	5617-11234

2.2.2 Wavelength

The wavelength of a sound wave is the distance between the start and end of a sound wave cycle or the distance between two successive sound wave pressure peaks shown in Fig (2.3). Numerically, it is equal to the speed of sound in the material such as air divided by the frequency of the sound wave. For example The wavelength of a 100 Hz tone at room temperature is 1130 ft/sec divided by 100 Hz which is equal to 11.3ft.[10]

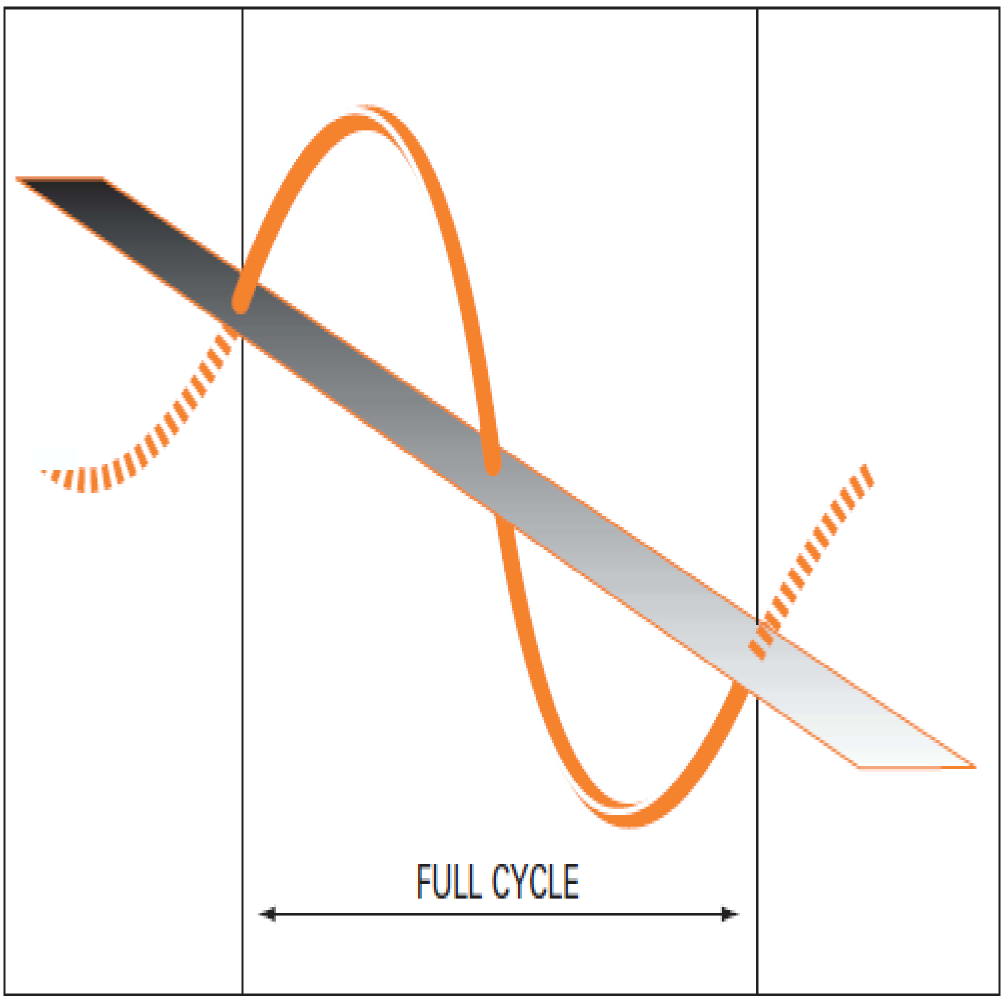


Figure 2.3 wavelength : the distance from start to end of a cycle [10]

2.2.3 Amplitude (loudness)

The amplitude or loudness of a sound wave is expressed by its sound pressure level. Sounds having the same wavelength(equal frequency) may have different loudness shown in Fig (2.4)

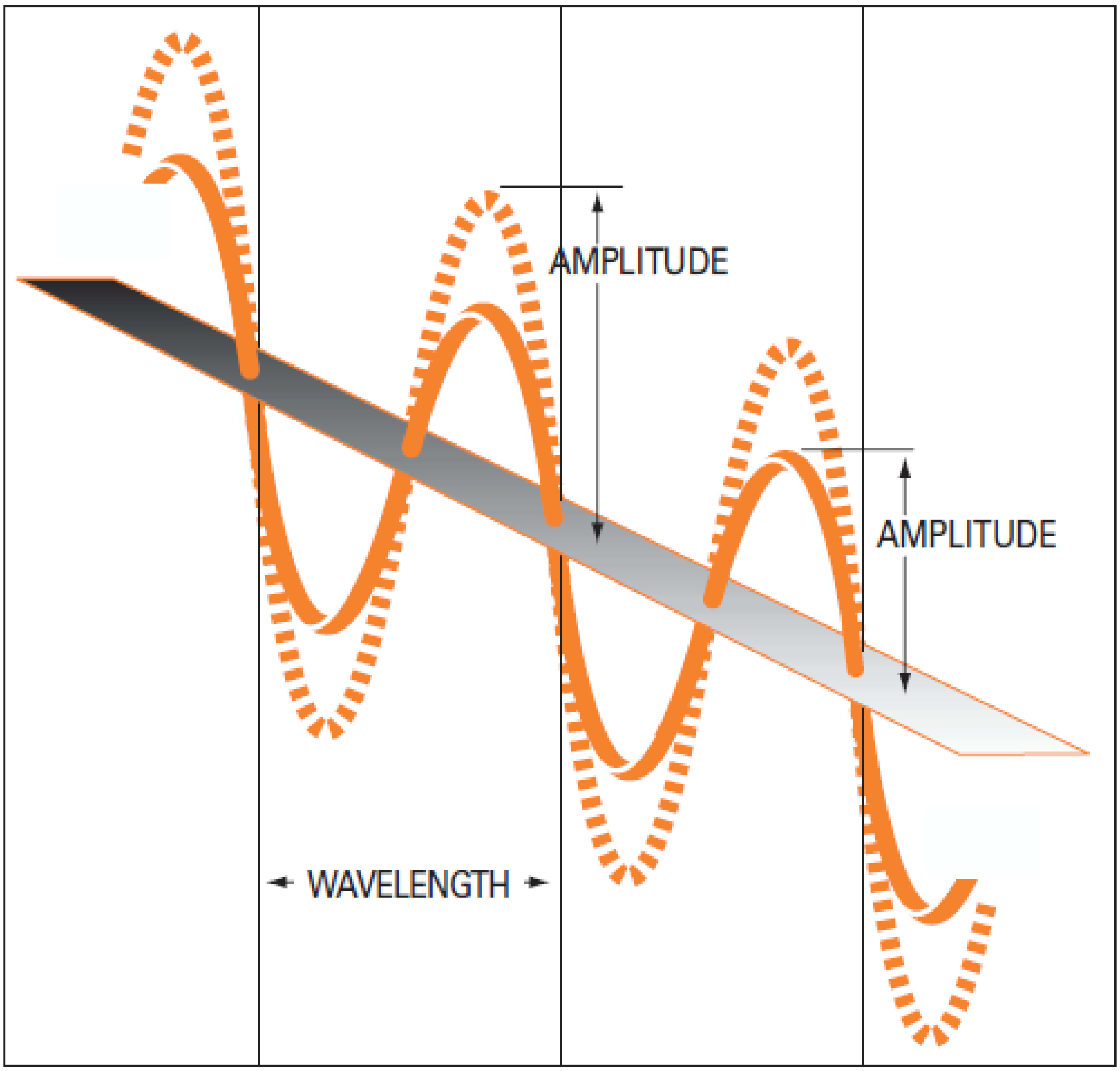


Figure 2.4 Two sound of equal frequency and differing amplitude [10]

Because the sound pressure of a sound wave may vary over a wide range-a change in magnitude of ten million to one-sound pressure is expressed using a logarithmic scale. This is the basis of the decibel scale, which compresses the range of sound pressure into a scale from 0 to 150. The decibel (dB) is not an actual measure of amplitude or loudness, but expresses the ratio between a given sound pressure and a reference sound pressure. This relationship is expressed by the following equation:

$$Lp = 10 \log (P/Pre)^2$$

Where: Lp is the Sound Pressure Level

P is the Sound Pressure (Pa)

Pre is the sound pressure at the threshold of hearing (0.00002 Pa).

Table 2.2 gives sound pressure levels in dB and sound pressure in Pascal's (Pa) for various sounds within the human ear's hearing range. Note that, because the decibel scale is logarithmic, a sound pressure level of 80 dB is 1.000 times that of the sound pressure level at 40 dB, not just three times.[10]

Table (2.2). Sound pressure levels for various sounds [10]

Source of noise	Sound pressure level db	Sound pressure level Pa
Threshold of pain	120	20
Loud rock music	110	6.3
Metalworking plant	100	2
Average street noise	70	0.06
Average office noise	60	0.02
Quiet residential street	50	0.006
Very quiet home radio	40	0.002
Inside a country home	30	0.0006
Threshold of hearing	10	0.00006

2.3 PHYSICS OF EAR

Noise causes sound waves that make our ear drums vibrate. These vibrations are received by hair cells in the inner ear, which flatten according to the frequency and loudness of the sound and stimulate nerves that pass messages to the brain. The ear act as a translator and translates mechanical wave information into electrical wave information for brain and also help you keep your balance.

The ear is made up of three different sections: the outer ear, the middle ear, and the inner ear. These parts all work together so you can hear the sound, and the construction of ear is shown in fig(2.5).

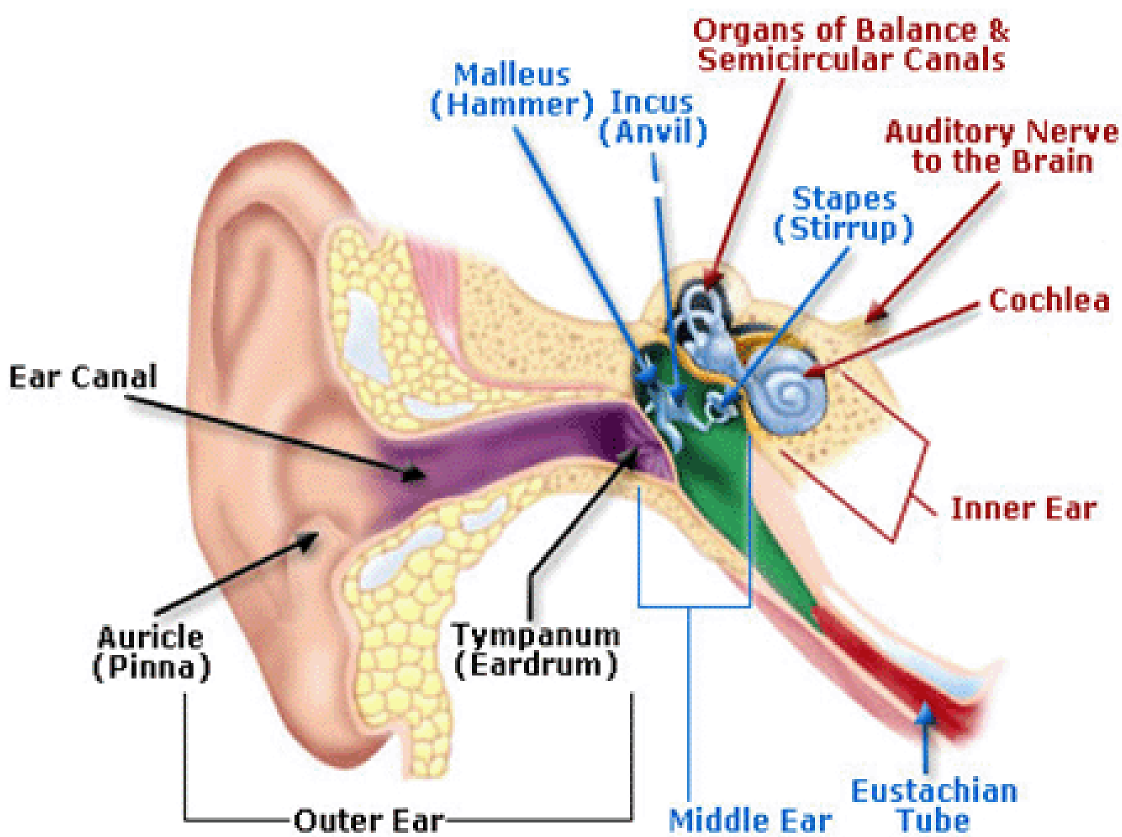


Figure 2.5 construction of ear[11]

The outer ear collects and funnels sound waves along the ear canal to the eardrum.

The middle ear contains three tiny bones: hammer, anvil and stirrup are called ossicles. When sound waves strike the eardrum, the ossicles conduct the vibration to the cochlea in the inner ear.

Hair cells within the inner ear respond to vibrations by generating nerve impulses. The brain interprets this as sound. It is the hair cells that are damaged by excessive noise, which leads to deafness. [12]

2.4 EFFECT OF NOISE ON HEARING

Very loud sounds make the hair cells collapse and flatten temporarily, resulting in temporary deafness. This is referred to as a temporary threshold shift and may last hours or longer depending on the degree of noise exposure. This temporary hearing loss may also be accompanied by a ringing sensation called tinnitus. If this severe noise exposure is repeated over many years, the hair cells in the inner ear become permanently damaged resulting in permanent hearing loss. This is referred to as permanent threshold shift. Immediate permanent hearing loss can also occur if someone is exposed to very intense or explosive sounds (e.g. gunshot or an explosion). This type of damage is known as acoustic trauma. In some cases a very intense sound can actually perforate the eardrum. The harmful effects of noise are cumulative and not necessarily confined to the workplace. For instance, the use of personal stereo units and frequenting discos and clubs may result in young people having some early damage to their hearing before they even join the workforce. [12]

2.5 NOISE EFFECT ON LIFE

Noise-induced hearing loss is one of the most common occupational injuries, resulting in health problems for many workers and it presents a significant social and economic cost to Libya. The human cost is also high. This includes lost jobs, increased absenteeism, reduced performance, lost opportunities for promotion or other employment and impaired family and social relationships. In addition, if your hearing is damaged it could cause a workplace accident. The first sign of noise-induced hearing loss is often the difficulty to hear high-pitched sounds, such as consonants (e.g. ‘t’, ‘d’, ‘s’) and the voices of women and children. When more than one person is speaking or there is a background noise, the problem becomes worse. Noise-induced hearing loss occurs gradually over a long period of time and unfortunately, hearing loss is permanent.

2.6 HAZARD OF NOISE

As people respond differently to noise, the level at which noise will start to cause damage is not known. The amount of damage caused by noise depends on the total amount of energy received over time. This means, as noise becomes louder it causes damage in less time. A 3dB(A) increase in noise level will produce twice the energy output and cause the same damage in half the time. shows the different exposure times for different sound levels, all equivalent to exposures of 85 dB(A) for eight hours. For example, two minutes of working in noise levels of 109 dB(A) may cause the same damage as eight hours working in 85 dB(A). Long periods of repeated exposure to workplace noise levels between 75 dB(A) and 80 dB(A) present a small risk of developing a hearing disability. As noise levels increase, the risk becomes greater. For example, exposure to noise levels of 85 dB(A) to 90 dB(A) presents a considerably greater risk of a developing hearing disability. The acceptable noise exposure standard in the workplace is 85 dB(A) averaged over an eight-hour period. This is not to imply that below 85 dB(A) a safe condition exists. It simply means that an eight-hour exposure of 85 dB(A) is considered to represent an acceptable level of risk to hearing health in the workplace. Impulse noise levels in excess of the peak exposure standard of 140 dB(C) are considered to be hazardous and capable of causing immediate hearing damage. [12]

2.7 DIFFICULTS OF HEARING AT WORK PLACE

1) Difficulties of voice to communicate between people.
2) Use the ringing in the ears or dull hearing, either after work or after a particular job .
3) Hard hearing car radio or television after a day at work

2.8 PROBLEM OF NOISE EFFECT ON HEALTH

2.8.1 Noise and sleep disorders

A proper sleep is of almost importance for the good mental and physical health. Noise pollution originating from traffic, airplanes and other anthropogenic reasons may cause severe sleep disturbance. The negative health effects of sleep deprivation include risk of cardiovascular diseases, cognitive disorders, hormonal changes, decrease in concentration and reaction.[14]

A field study of road traffic noise with 106 individuals demonstrated negative effects of noise on health, such as changes in mood, tiredness, headaches and stomach disorders. [15]

2.8.2 Noise and cardiovascular diseases

Exposure to the high levels of noise was shown to cause decrease in the blood flow (because of vasoconstriction), higher blood pressure and heart rate thus indicating the involvement of autonomous nervous system in the response to the noise.[16]

2.8.3 Noise and cognitive performance

Several laboratory and field studies documented correlation between noise exposure and performance of students. For example, one study compared cognitive abilities of students from noisy schools (exposed to the higher level of the aircraft noise) to those from quiet schools.

The obtained results were consistent with laboratory studies and indicated that students from noisy schools showed poorer performance in cognitive tasks and were more likely to give up assignment before deadline. Besides, the student from noisy environment had a higher blood pressure than students from quiet schools. [17]

2.8.4 Noise and endocrine system

Endocrine system is a system of glands that excretes hormones directly into the blood. These hormones regulate growth and development of the body, sexual functions and mood. Some stress hormones.[18]

Investigated the effect of high ambient noise (90 dB) in glass factory workers by measuring catecholamine's and cortical in serum and homovanillic and vanilmandelic acids in the urine. Those test subjects exposed to higher noise levels had statistically significantly higher concentrations of vanilmandelic acid, nor epinephrine and epinephrine. The authors concluded that higher levels of stress hormones led to the stimulation of sympathy-adrenal system and may result in future in cardiovascular disorders due to high noise levels.[16]

Also demonstrated higher levels of urinal adrenaline and nor adrenaline in women exposed to the outdoor traffic noise. Above mentioned studies suggest that stress hormones are good indicators in the research of noise effects on the human body. Other stress factors (social, chemical biological) may also aggravate the effect of noise on health with some studies showing greater effects than simply arithmetic sum of stress factors. [19]

2.8.5 Economic impact of noise pollution

Economic losses due to road traffic noise in Europe are estimated to be 46 billion euro's per year. Due to the highly developed motorway network in Europe have the majority of economic costs is attributed to passenger cars and trucks. Financial losses from noise arise from higher health expenditures due to noise related disorders, lower productivity of workers, construction costs to build insulation, barriers and sound proof buildings.[20]

2.9 MEASUREMENT OF NOISE INSTURMENT

The measurement of sound and its characteristics plays an important role in the development of a systematic approach to noise control. In particular, The measurement of overall sound levels can be used to determine compliance with regulation or pertinent criteria[21]. These measurements can also be used to assess the effectiveness of various control methods and to establish realistic goals. Although measuring sound level is an essential aspect of characterizing noise, Other parameters associated with noise, such as duration and spectral content, Are often equally as important today, Sound measurement instrumentation embodies a wide range of complexity and sophistication. The need to understand the capabilities and limitations of this equipment is critical in order to properly interpret measurement results. The purpose of this chapter is to introduce the various types of available sound measuring and analysis tools, and to discuss the basic applications of these instruments, As following.

2.9.1 Sound level meter

The primary instrument for field sound measurement is the sound level meter (SLM) there are many types commercially available sound level meter shown in figs (2.6),(2.7) and (2.8).

Figure 2.6 Digital Sound Level Meter, Make – Lutron SL 4001 [22]

Figure 2.7 Integrating sound level meter, Code: ST107 [23]

Figure 2.8 Sound level meter class2. [24]

The principal components of any sound level meter are illustrated in the block diagram shown in fig (2.9) and consist of the following:

1) Microphone. The microphone senses the sound pressure fluctuations and converts them to an analogy electrical signal.
2) Preamplifier. The preamplifier is used for impedance matching and can sometimes provide a DC polarization voltage to the microphone.
3) Frequency weighting network. This stage provides a system of networks , generally A, C and linear, which are used to modify the frequency response characteristics of the measurement instrument. The selection of the appropriate frequency weighting characteristic is dependent upon the type of measurement being made.
4) Range control amplifier. Most sound level meter detectors have a limited range of signal level for which they accurately operate. This amplifier is used to adjust the signal voltage to levels which are within this range.

5) Detector. This element is used to characterize the incoming signal amplitude. There are several types of detector that are commonly used . They include RMW (root mean square), peak, and integrating.
6) Display. Once the amplitude of the signal has been detected the display is used to indicate this level. Generally, SLM display are scaled in decibels referenced to the international standard of $2 * 10^{-5}$ pa .
7) Outputs. Sound level meters often provide signal outputs in order to obtain advanced analysis capabilities and graphical hard copy. [21]

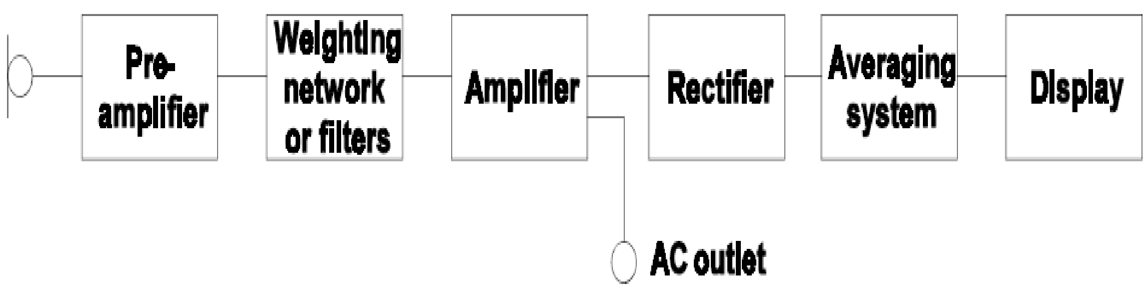


Figure 2.9 sound level meter Block diagram. [25]

2.10 TYPE OF NOISE LEVEL METER DEVICE

There are many type of noise level meter device we will study and take important to dosimeter level meter because this device used in measuring process to take measurements in this research.

2.10.1 Frequency Analysis

The importance of frequency analysis as an acoustic diagnostic and design tool cannot be overemphasized. The ability to measure a spectrum of an acoustic signal can often enable one to identify and separate specific noise sources. This information can allow the acoustic engineer to rank-order noise sources in terms of signal level and frequency content. The advantage associated with this is that noise control efforts can become more effective, efficient, and systematic. It can greatly reduce the length of time it takes to measure a spectrum. This can be particularly important when an event is transitory (e.g truck or train pass by).Today, real-time analyses are generally implemented using digital signal processing techniques. Several commercially available real-time octave and 1/3 octave band analyses. [21]

are shown in fig(2.10), (2.11) and(2.12).

Figure 2.10 NTI XL2 Sound Level Meter and Acoustic Analyzer with M4260 Microphone .[26]

Figure 2.11 Anritsu MS2661C Spectrum Analyzers. [27]

Figure 2.12 Advantest R3261C Spectrum Analyzers [28]

2.10.2 Graphic Level Recorder

The graphic level recorder shown in fig(2.13) plays a fundamental role in sound measurement. This instrument provides a permanent, Reproducible, Hard-cope trace of the noise level time history, As shown in fig(2.14). As an accessory to sound measurement instrumentation graphic level recorders can be used over long periods of time to record time-varying noise levels such as those found outdoors.

Most recorders are of a servomechanism type wherein the servo drives a marking pen over an accurately advancing paper strip chart. The resolution of the noise level versus time trace is controlled by selecting strip chart paper speed, typical recorders offer a range of 0.0003 to 100 mm/s. pen or marker writing speeds. Will typically range from 2 to 2000 mm/s. [21]

Few guidelines can be given for the operation of graphic level recorders since each application requires some judgment. For example, if one wants to record the time history of a cyclical noise pattern produced by an automatic bar machine, two primary considerations must be made.

Figure 2.13 The Yokogawa DL850 ScopeCorder 100 MS/s, 8 slots. [29]

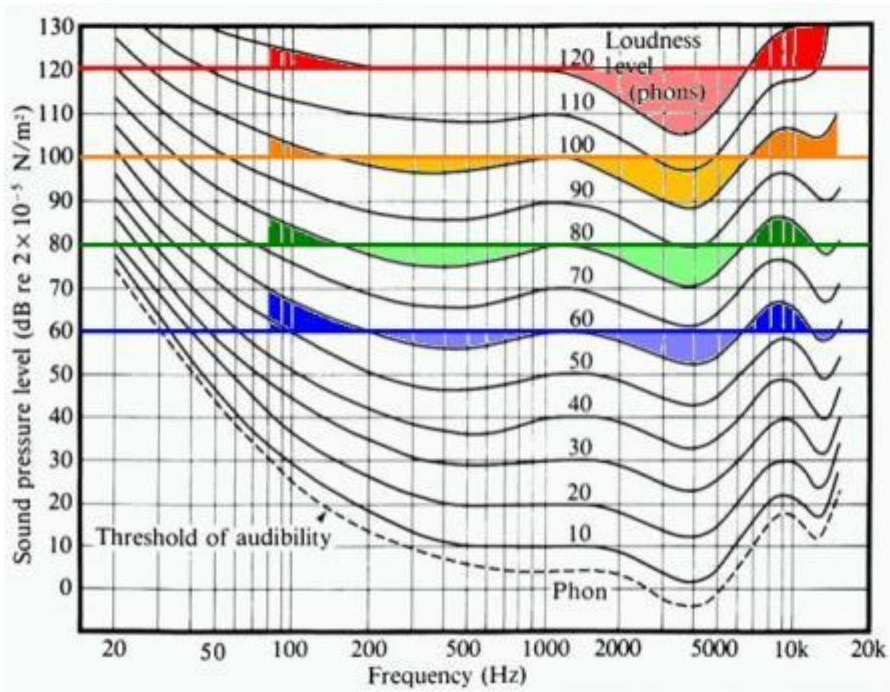


Figure 2.14 graphic level recorder showing A- weighted community levels versus time. [30]

2.10.3 Tape Recorders

Tape recorders in noise control engineering are a valuable tool. By recording sound signals on a tape recorder, the acoustic engineer is able to bring the sound source into the laboratory for detailed analysis. Here, the signal can be replayed and analyzed as many time as necessary to obtain a full understanding of the character of the signal. This can be particularly valuable when the sound signal is an event of short duration such as a train or truck pass by. With the tape-recorded signal, it is possible to obtain a spectrum of the event with a serial analyzer. Finally, tape recorded signal can be stored and archived as part of a permanent record.

Field tape recorders vary from small, lightweight cassette recorders to slightly heavier reel-to-reel types. Today, tape recorders utilize either analog or digital methods for storing data on magnetic tape. Two commercially available instrumentation recorders are shown in fig(2.15) and fig(2.16) As well be seen, from the standpoint of accuracy. The specification of most digital audio tape (DAT) recorders far exceed the specification of analog recorders. Ideally during playback, the tape recorder should reproduce the recorded signal exactly. However, due to various limitations associated with frequency response, internal noise, and tape speed control, there are inherent limits to the accuracy. (portable tape recorders for field sound measurement. analog reel-to reel tape recorder)

Figure 2.15 THE NAGRA IV-S…. 'two track magic [31]

Figure 2.16 Tascam DR-680 Digital DAT recorder[32]

2.10.4 Sound intensity analysers

There are two main application for sound intensity measurements:

The first is for the determination of the sound power of a noise source. In this application, several sound intensity measurements are made over a conformal surface which completely encloses the noise source.

A second application of sound intensity measurement is for noise source localization. In this application, the directional characteristic of the sound intensity probe are utilized. Here, many measurements are made at equal spaces on a grid which surrounds the noise source. Regions of high sound intensity identify localized noise sources. Therefore, to reduce noise emission, treatments in these areas will be most effective, as shown in fig (2.17) and fig(2.18).

Figure 2.17 sound intensity analyzers. Larson Davis Sound Level Meter Rental [33]

Figure 2.18 Portable 2-channel acoustics and vibration data acquisition system.[34]

2.10.5 Environmental or community noise monitors

When performing environmental noise surveys, one must recognize that variation in noise levels will continually occur. Environmental noise monitors are sound level meters that have been developed to measure and describe the temporal characteristics of community noise. The distinctive feature of environmental noise monitors is that they can be left unattended for several hours, or even days, together sound level information this requires long battery life, rugged packaging (including the microphone), and the capability to logically compress vast amounts of data. In most environmental noise monitors, sound levels are continuously sampled during the entire period that can be programmed into the instrument, and an internal clock is used to log all measurements. A digital processor is utilized to calculate statistical descriptors on an interval basis (usually hourly) and to store this information. Stored data is later might include hourly listings of a wide range of the community noise. Several commercial available community noise monitors are shown in fig (2.19) and fig (2.20) .

Figure 2.19 979 Sound Level Meter and Analyze.[35]

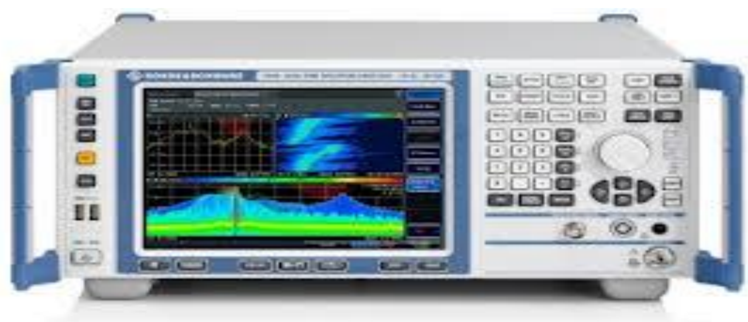


Figure 2.20 R&S®FSVR Real-Time Spectrum Analyzer.[36]

2.10.6 Dosimeter

Noise dosimeters are widely used for monitoring noise in workplace environments where sound levels may be hazardous to hearing. Basicall, the dosimeter integrates a weighted function of sound pressure or sound pressure level over a time period to determine noise dose, which is a percentage of permissible exposure criteria. [21]

several dosimeter which are designed for measuring daily personal noise exposure in accordance with various regulations shown in the figure below.

Figure 2.21 Sound Level Meter dB adge CEL-350/K1[37]

Figure 2.22 Quest noise pro noise dosimeter[38]

Figure 2.23 SL355 - Personal Noise Dosimeter [39]

Most often these instruments are worn on the person, with the microphone location on the shoulder. When not worn by a person, they may be used as an area monitor. The dosimeter can be broken down into three basic components operating in series: A sound level meter, An integrator and a readout device. The overall response and quality of the sound level meter is controlled by standards, and minimum standards are usually specified by regulations. The integrator section electronically integrates a power function of the mean-square signal over time. The specific power function to be integrated depends on the applicable exposure criteria. [21]

There for according to the specification of the dosimeter, in this research will be use dosimeter model number CEL-360 shown in fig (2.24).

Figure 2.24 Dosimeter model number CEL-36

2.11 NOISE CONTROL IN THE WORKPLACE

2.11.1 Noise Control Program

If the noise levels in the workplace are in excess of the exposure standards, steps must be taken to reduce noise levels and protect employees. This can be achieved by introducing noise control measures as part of a noise control program. A noise control program sets out ways to minimize noise exposure in the workplace.

The key elements of a noise control program are:

1) A noise policy statement
2) Assessing and prioritizing noise problems for attention
3) Engineering and administrative noise control measures
4) Education and training
5) Personal hearing protection

6) Audiometric testing
7) Evaluation of the effectiveness of the program.

Other elements could be a ‘buy quiet’ program and setting an organizational target for noise levels that is lower than the current exposure limit. Implemented noise control measures can help to minimize the risks of noise induced hearing loss. The following hierarchy of noise control measures should be followed:

1) Elimination of the noise source
2) Substitution
3) Engineering controls
4) Administrative controls
5) Personal hearing protection equipment.

Priority for taking action should be given to the noise sources that contribute the highest noise exposure to the largest number of workers. If administrative noise controls or the use of personal hearing protection equipment are relied on, there should be regular checks to ensure compliance is occurring.

Training must be given to workers exposed to excessive noise levels and to those responsible for purchasing plant, noise control equipment and hearing protectors.

2.11.2 Practical Noise Control Measures

Reducing noise at the source .This can be done by:

1) Replacing outdated, noisy machinery .
2) Using quieter materials and equipment by:

- Replacing metal gears with fiber or nylon gears .
- Replacing roller conveyors with belt type conveyors.
- Avoiding metal to metal contact by using plastic or rubber bumpers .
- Using lagging to dampen vibrating surfaces .

- Using mufflers to silence gas or air flow .

3) Checking the noise levels of machinery before purchasing it and having a company policy of purchasing only quiet equipment .
4) Separating noisy elements, such as pumps, fans and compressors that are not an integral part of the basic machine, from the work area occupied by employees .
5) Modifying material handling processes to reduce the noise from shock and impact e.g. Reducing the distance where objects fall onto hard surfaces or fixing damping material to surfaces or containers .
6) Improving maintenance programs .

2.11.3 Blocking the noise transmission path

This can be done by:

1) Moving noisy machines or processes to remote areas of the workplace.
2) Fitting sound absorbent materials to ceilings and walls .
3) Enclosing noisy machinery within sound absorbent materials .
4) Mounting noisy floor standing machinery on rubber pads to reduce vibration
5) Fitting flexible or fixed screens or curtains of sound absorbent material.
6) Limiting entry of people in areas where there is excessive noise.
7) Preventing staff exposure to noise (Administrative controls), and this can be done by:

- Scheduling noisy work for times when as few workers as possible are present.
- Building sound-proof booths for operators of noisy equipment.
- Rotating staff in noisy areas so that each person's daily exposure to noise is reduced.

2.11.4 Personal hearing protection

A last resort is to use personal hearing protection such as earmuffs or earplugs. Employees must be trained in fitting and wearing earmuffs and earplugs. Hearing protection must be worn for the entire duration of a noisy shift. Wearing hearing protection for only part of the shift is not sufficient. Routine maintenance and replacement procedures are also needed for the personal hearing protection equipment. Personal hearing protection equipment must be of an approved all employees with good type from it.[18]

2.15 OSHA STANDARD

There are many standards to safety noise. Such as, the national Institute for occupational safety and health(NIOSH), World Health Organization (WHO) and American National Standards Institute (ANSI). In this study the OSHA Standard will be used.

The success of a hearing loss prevention program is determined by several components. These components should include the following:

1) Noise exposure monitoring.
2) The presence of a noise control process.
3) Provision of hearing protection.
4) Education of all employees and notification of hazardous noise areas.
5) Availability of audiometric testing for workers.
6) Record keeping of the program's events.
7) An effective program evaluation. [40]

Today, the literature is lacking in terms of deeming a noise prevention program successful. Perhaps the success in the field is the enforcement of prevention programs in workplaces across the nation as determined by organizations such as Organization Safety Health Association (OSHA), Currently, there are on-going studies to determine the efficacy of noise prevention programs such as hearing conservation programs for miners and carpenters. Results should be available in approximately 5-6 years. [41]

In this study we used (OSHA standard) to comparing the reading at all point or all location with this standard, OSHA concern with noise exposures began primarily in the workplace. Guidelines for occupational noise exposure were established by the Occupational Safety and Health Administration (OSHA). OSHA were created by the Occupational Safety and Health Act of 1970.[42]

OSHA is part of the U.S. Department of Labor and is responsible for developing and enforcing workplace safety and health regulations. The OSHA standard (29CFR1910.95) carries behind it the force of law and employers in the industrial sector are bound to comply with it. Those employed in mining, railroad, coast guard, military, and construction are bound by their own standards.

2.15.2 Limiting Noise Exposure(Damage -Risk Criteria):

How long and how loud can we listen to sound without risking hearing damage? Damage-risk criteria provide the basis for recommending noise exposure limits based on noise level and exposure time. OSHA criteria are shown in table (2.3).

Table (2.3) Duration (in hours) of allowable exposures based on OSHA criteria. PEL=Permissible Exposure Limit. Noise exposure levels/times exceeding those shown in table (2.3) require the use of hearing protection.

Table (2.3) OSHA PEL standard [43]

Levels, in dB A	85	88	90	92	95	97	100	102	105	110	115
OSHA PEL	16		8	6	4	3	2	1:30	1	0:5	0:25 or less

permits exposures of 85 db A for 16 hours per day, and uses a 5-dB time-intensity tradeoff: for every 5 dB increase in noise level, the allowable exposure time is reduced by half. For every 5 dB decrease in noise level, the allowable exposure time is doubled. All time/intensity values shown on the OSHA PEL line in table (2.3).Are assumed to have equal risk to each other, that is, 16 hours at 85 dB carries the same auditory risk as 8 hours at 90 dB, 4 hours at 95 dB, 2 hours at 100 dB, and so on.

Chapter 3

CASE OF STUDY (AL ZAWIH POWER STATION)

3.1 Introduction

Al zawih power station one of most important of power generation in General electric company in Libya. It's capacity is 400 MW from three steam turbine unit and six gases turbine unit. Location Al zawih power station is in north west of Alzawih city as shown in fig (3.1) . Al zawih power station far from Tripoli city approximate 45 km. The Total number of man power station 296 employees and all man power are Libyan nationality[44] .

3.2 LOCATION OF THE STUDY

North west of Al zawih city, figure (3.1)

Figure 3.1 location of Al zawih power station [45]

3.3 MANPOWER

The Total number of man power in the station is 296 employees which are dividing as following:

1) management department, 32 employee[44]
2) Maintenances workers ,85 employee[44]
3) Operation workers ,138 employee[44]
4) other workers ,41 employee[44]

3.4 THE CAPACITY OF THE POWER STATION

Table (3.1) shown the Total production power during each year from 2000 to 2012[44]

year	Total production power by KWh
2012	8056150.6
2011	7893201.6
2010	7372839.8
2009	7143019.3
2008	6332568.0
2007	4736123.3
2006	4080659.0
2005	3484020.0
2004	3067888.0
2003	2648475.0
2002	2423869.0
2001	2219239.0
2000	551215.0

3.5 STEPS OF NOISE MEASUREMENT

- First step : select the locations point to be measured, 33 locations in the power station. Were selected according to their relationship to the source of noise and their exposing to employee from the point of view of power station management .
- Second steps : use the dosimeter device to measure the level of the noise for a period of five minutes in different five days during the operating shift.

3.5.1 First steps: Selected the work places

According to more than five visit to the electric power station and the discussion with the top management and other level of the employees about the sources of noises in the working places . it has been decided to select the following locations starting from X1,X2,X3 ………………………X33 as following.

Steam turbine unit (3)(STU3)

- locationX1 : Refer to low pressure feed pump,(STU3).

Figure 3.3 at low pressure feed pump,(STU3)

- locationX2: Refer to the door of unit,(STU3) .

Figure 3.4 at the door of unit,(STU3)

- locationX3: Refer to 4,20 m from X2 inside the unit,(STU3).

Figure :(3.5) 4,20 m from X2 inside the unit,(STU3)

- locationX4: Refer to 6 m from X2 outside the unit, (STU3) .

Figure 3.6   6 m from X2 outside the unit,(STU3)

- locationX5: Refer to 13 m from X2 outside unit,(STU3).

Figure 3.7   13 m from X2 outside unit,(STU3)

- locationX6: Refer to high pressure feed pump,(STU3).

Figure 3.8 At high pressure feed pump,(STU3)

- locationX7: Refer to between two source noise X6 and X8,(STU3).

Figure 3.9   Between two source noise X6 and X8,(STU3)

- locationX8: Refer to steam turbine,(STU3) .

Figure 3.10   At steam turbine,(STU3)

- locationX9: Refer to generator,(STU3) .

Figure 3.11 At generator,(STU3)

Steam turbine unit (2)(STU2)

- locationX10: Refer to low pressure feed water pump,(STU2) .

Figure 3.12 At low pressure feed water pump,(STU2)

- locationX11: Refer to high pressure feed water pump,(STU2).

Figure 3.13 At high pressure feed water pump,(STU2)

- locationX12: Refer to Between two source noise X11 and X13,(STU2).

Figure 3.14 Between two source noise X11and X13,(STU2)

- locationX13: Refer to steam turbine,(STU2).

Figure 3.15 At steam turbine,(STU2)

- locationX14: Refer to generator,(STU2) .

Figure 3.16 At generator,(STU2)

- locationX15: Refer to Between two noise source , generator and lube oil system,(STU2) .

Figure 3.17 Between two noise source , generator and lube oil system,(STU2)

Steam turbine unit(1)(STU1)

- locationX16: Refer to Low pressure feed water pump, (STU1).

Figure 3.18 Low pressure feed water pump, (STU1)

- locationX17: Refer to High pressure feed water pump, (STU1).

Figure 3.19 High pressure feed water pump, (STU1)

- locationX18: Refer to Between two noise source X17 and X19, (STU1).

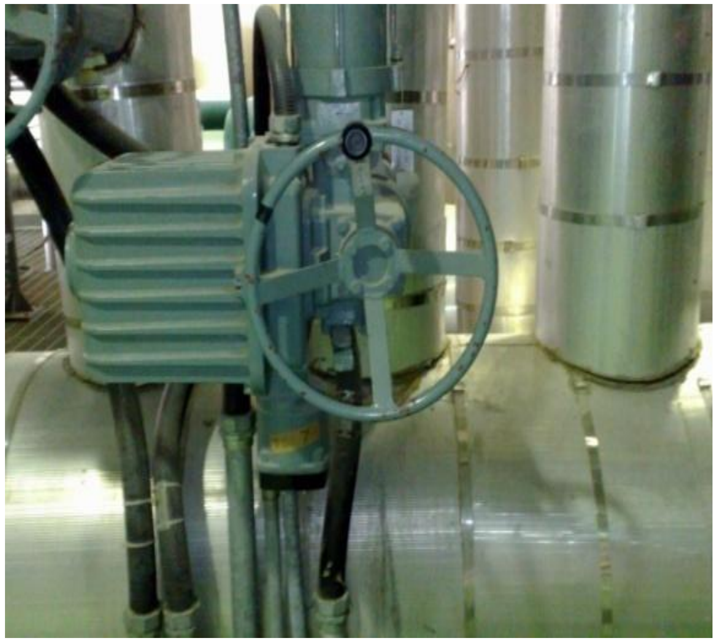


Figure 3.20 Between two noise source X17 and X19, (STU1)

- locationX19: Refer to steam turbine, (STU1) .

Figure 3.21 At steam turbine, (STU1)

- locationX20: Refer to generator , (STU1).

Figure 3.22 At generator, (STU1)

- locationX21: Refer to Between two noise source, generator and lube oil system, (STU1).

Figure 3.23 Between two noise source, generator and lube oil system, (STU1)

Cooler system unit,(CSU)

- locationX22: Refer to cooler water, (CSU).

Figure 3.24 At cooler water,(CSU)

Fuel forwarding pump unit, (FFPU)

- locationX23: Refer to the door fuel forwarding pump, (FFPU).

Figure 3.25 At the door fuel forwarding pump, (FFPU)

- locationX24: Refer to 4,20 m from X23 inside room, (FFPU) .

Figure 3.26 4,20 m from X23 inside room, (FFPU)

- locationX25: Refer to 4,30 m from X24, (FFPU) .

Figure 3.27 4,30m from x24, (FFPU)

Gas turbine (14)(GT14)

- locationX26: Refer to auxiliary boiler room, (GT14).

Figure 3.28 At auxiliary boiler room, (GT14)

- locationX27: Refer to Inside (lube oil system) room, (GT14).

Figure 3.29 Inside (lube oil system) room, (GT14)

- locationX28: Refer to (variable inlet gaud van VIGV) room, (GT14).

Figure 3.30 At (variable inlet gaud van VIGV) room, (GT14)

- locationX29: Refer to the door (1) to trust bearing joint between compressor and generator room, (GT14) .

Figure 3.31 At the door (1) to trust bearing joint between compressor and generator room, (GT14)

- locationX30: Refer to the door (2) to trust bearing joint between compressor and generator room, (GT14).

Figure3.32 At the door (2) to trust bearing joint between compressor and generator room, (GT14)

- locationX31: Refer to the door gas turbine room, (GT14).

Figure 3.33 At the door gas turbine room, (GT14)

- locationX32: Refer to the door generator room, (GT14).

Figure 3.34 At the door generator room, (GT14)

- locationX33: Refer to the door auxiliary boiler room 2, (GT14).

Figure 3.35 At the door auxiliary boiler room 2, (GT14)

3.5.2 Second step: calibration process

First step of the measurement processes is the calibration of the dosimeter device as shown in fig(3.36) .

Figure 3.36 Calibration to sound level meter device by calibrator device

3.5.2.1 The Calibration

The fundamental accuracy of sound level meters depends foremost on microphone calibration. Although sound level meters are generally rather stable instruments, in time, sensitivity may vary. As such, it is a basic premise of sound measurement to acoustically calibration the instrument immediately prior to the after field measurements. There are numerous ways to calibration a sound level meter. We shall limit the discussion to field calibration methods. Portable field calibrators usually consist of a vibratory piston or an oscillating diaphragm which is applied over the microphone capsule. The vibrating piston or diaphragm produces a precise, discrete sound level at the sensing element of the microphone . the sound level meter is then adjusted, usually by a small adjustment screw or digital offset, until the meter reading and sound level of the calibrator coincide. With this method, calibrators to within ± 0.2 db can be achieved. This is well within the accuracy required of most noise control measurement.

3.6 THE READING TAKEN IN FIVE DAYS

The period of time of study have been selected for five days according to the power station constraint, the following tables will show the summary of reading for the first day, second day, third day, forth day and fifth day. Respectively table (3.2) with fig(3.37), table (3.3) with fig.(3.38) , table(3.4) with fig.(3.39) , table (3.5) with fig.(3.40) and table (3.6) with fig.(3.41) .

3.6.1 Measuring at the First day

Table (3.2): RMS maximum level (Fast), RMS minimum level (Fast) and Peak exceedance level by db scale at first day measuring.

location	RMS maximum level (Fast)	RMS minimum level (Fast)	Peak exceedance level
X1	91.8 dB	85.2 dB	106.7 dB
X2	89.8 dB	79.9 dB	---.- dB
X3	83.0 dB	78.2 dB	104.3 dB
X4	92.9 dB	89.2 dB	110.6 dB
X5	94.5 dB	91.8 dB	112.6 dB
X6	91.3 dB	89.7 dB	109.5 dB
X7	94.5 dB	91.8 dB	112.6 dB
X8	94.4 dB	91.3 dB	112.9 dB
X9	90.9 dB	89.0 dB	112.7 dB
X10	92.1 dB	90.7 dB	110.7 dB
X11	95.2 dB	92.8 dB	111.7 dB
X12	96.1 dB	92.8 dB	110.1 dB
X13	96.7 dB	94.9 dB	111.5 dB
X14	94.2 dB	92.9 dB	111.0 dB
X15	90.9 dB	89.3 dB	111.0 dB
X16	89.3 dB	87.6 dB	109.3 dB
X17	92.2 dB	90.5 dB	110.7 dB
X18	92.3 dB	90.6 dB	112.4 dB
X19	93.5 dB	92.2 dB	113.0 dB
X20	93.3 dB	91.8 dB	112.9 dB
X21	91.5 dB	89.5 dB	110.8 dB
X22	94.1 dB	86.7 dB	119.1 dB
X23	99.3 dB	96.2 dB	115.9 dB
X24	101.2 dB	99.0 dB	116.8 dB
X25	101.7 dB	99.3 dB	118.2 dB
X26	91.7 dB	89.1 dB	112.3 dB
X27	107.8 dB	105.1 dB	121.4 dB
X28	104.8 dB	98.8 dB	118.1 dB
X29	111.4 dB	107.9 dB	124.6 dB
X30	112.7 dB	110.2 dB	128.2 dB
X31	96.3 dB	92.1 dB	113.6 dB
X32	105.7 dB	103.8 dB	122.5 dB
X33	101.0 dB	97.3 dB	117.7 dB

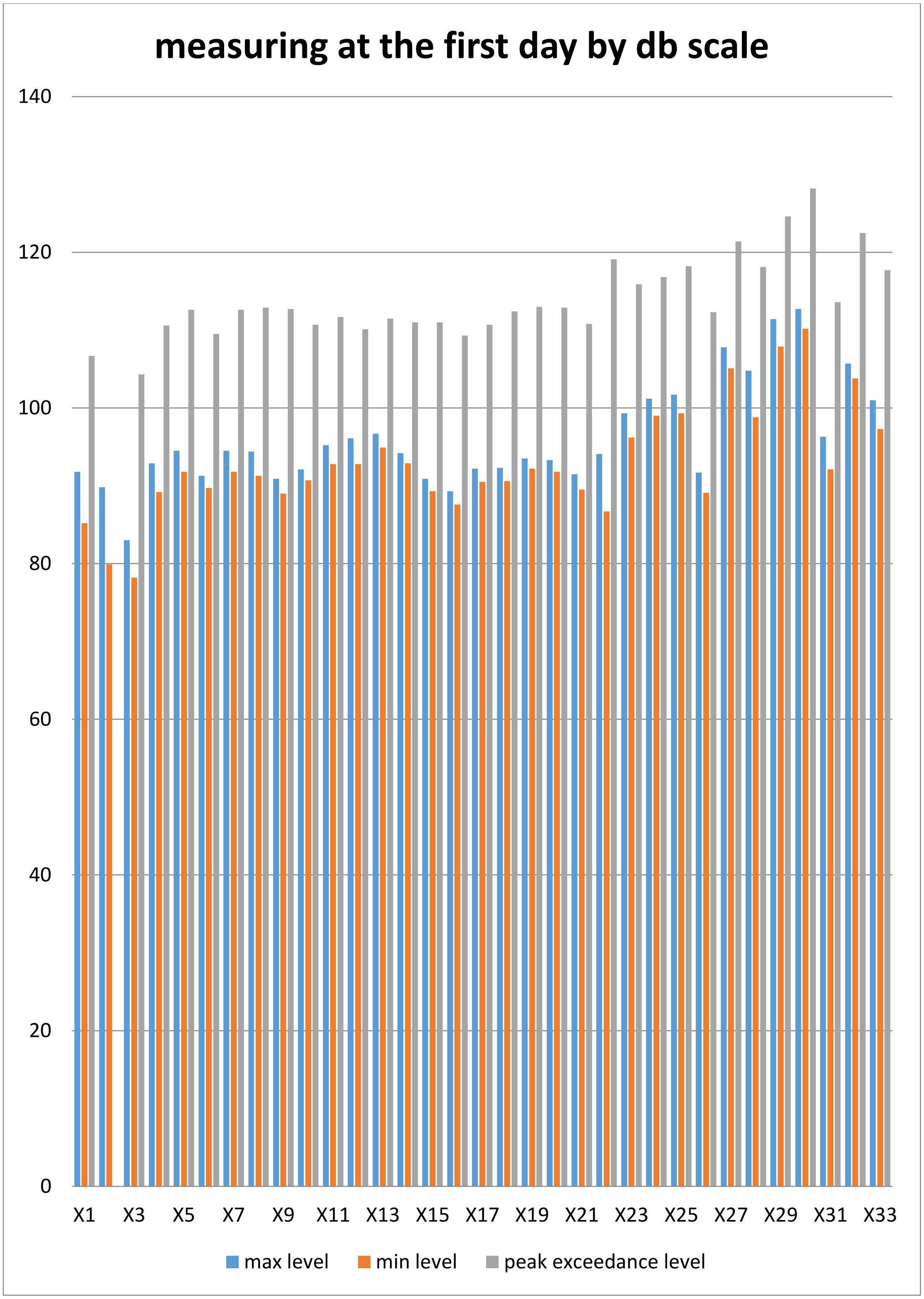


Figure 3..37 Maximum level, minimum level and peak exceedance level by db scale at first day measuring.

3.6.2 Measuring at the second day

Table (3.3): RMS maximum level (Fast), RMS minimum level (Fast) and Peak exceedance level by db scale at second day measuring.

Location	RMS maximum level (Fast)	RMS minimum level (Fast)	Peak exceedance level
X1	88.3 dB	80.2 dB	104.1 dB
X2	89.7 dB	85.4 dB	107.3 dB
X3	91.8 dB	89.8 dB	109.7 dB
X4	91.9 dB	89.1 dB	112.0 dB
X5	83.8 dB	78.5 dB	104.7 dB
X6	91.6 dB	90.0 dB	111.3 dB
X7	94.7 dB	92.1 dB	111.8 dB
X8	93.9 dB	92.1 dB	112.9 dB
X9	91.3 dB	88.9 dB	112.1 dB
X10	93.5 dB	90.0 dB	110.8 dB
X11	95.8 dB	94.1 dB	112.0 dB
X12	94.9 dB	92.7 dB	110.7 dB
X13	97.7 dB	94.5 dB	112.7 dB
X14	95.4 dB	92.8 dB	112.5 dB
X15	92.9 dB	88.6 dB	110.4 dB
X16	89.4 dB	87.4 dB	108.4 dB
X17	92.4 dB	90.4 dB	109.9 dB
X18	90.9 dB	89.2 dB	112.3 dB
X19	91.9 dB	90.2 dB	111.5 dB
X20	93.1 dB	90.1 dB	112.9 dB
X21	91.2 dB	87.4 dB	109.0 dB
X22	91.1 dB	86.2 dB	115.3 dB
X23	101.4 dB	98.3 dB	116.6 dB
X24	102.2 dB	99.4 dB	116.0 dB
X25	102.7 dB	99.4 dB	117.3 dB
X26	91.8 dB	89.2 dB	112.4 dB
X27	109.1 dB	106.2 dB	122.7 dB
X28	108.6 dB	100.7 dB	118.9 dB
X29	111.5 dB	107.6 dB	123.3 dB
X30	112.3 dB	107.5 dB	125.7 dB
X31	95.0 dB	91.8 dB	109.3 dB
X32	105.8 dB	104.0 dB	122.6 dB
X33	97.6 dB	94.7 dB	116.3 dB

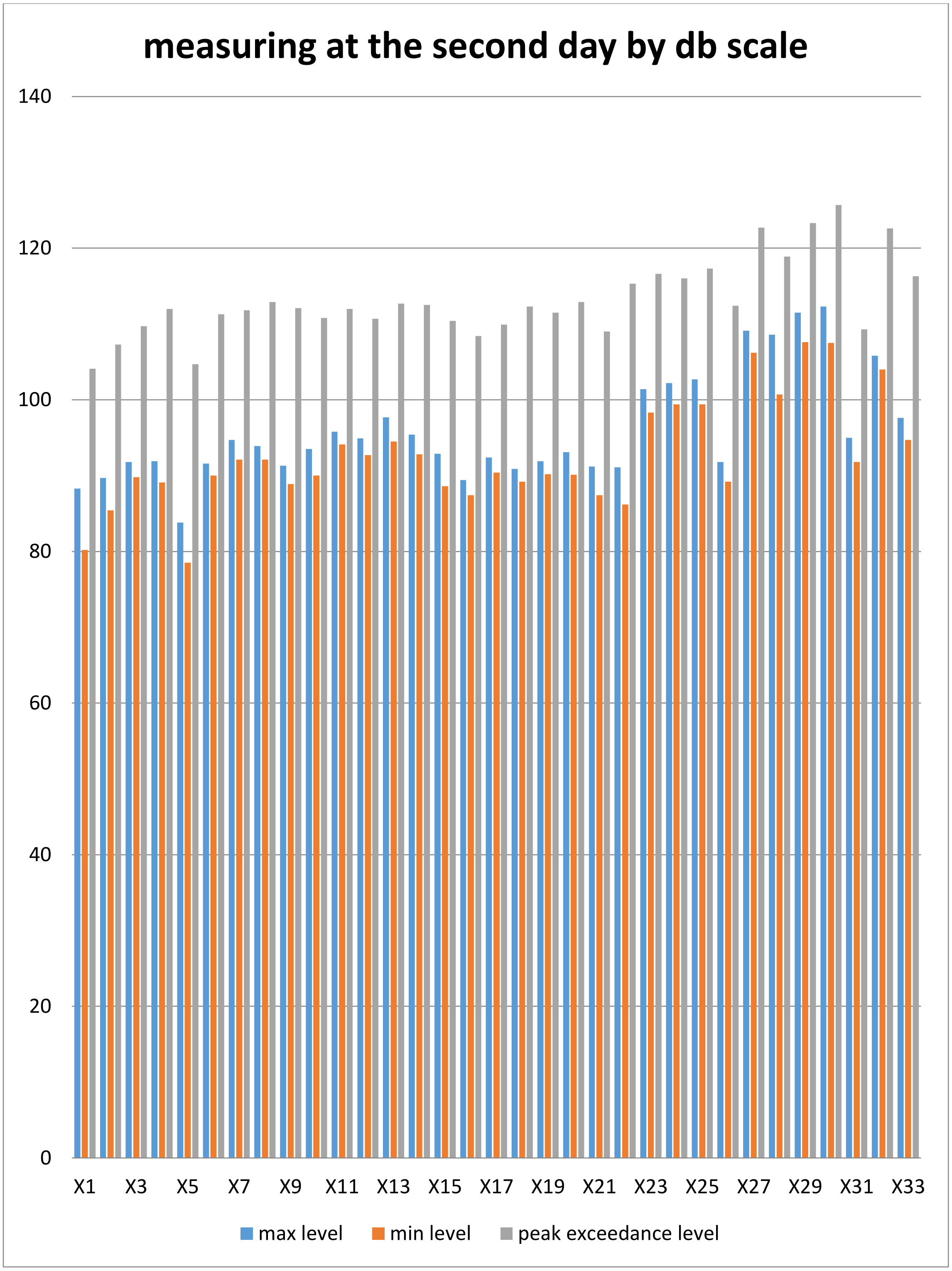


Figure 3.38 Maximum level, minimum level and peak exceedance level by db scale at second day measuring.

3.6.3 Measuring at the third day

Table (3.4): RMS maximum level (Fast), RMS minimum level (Fast) and Peak exceedance level by db scale at third day measuring.

Location	RMS maximum level (Fast)	RMS minimum level (Fast)	Peak exceedance level
X1	81.8 dB	78.5 dB	---.- dB
X2	89.4 dB	86.7 dB	111.6 dB
X3	93.5 dB	91.1 dB	109.5 dB
X4	92.7 dB	90.1 dB	111.2 dB
X5	79.9 dB	77.2 dB	104.5 dB
X6	93.8 dB	91.0 dB	110.3 dB
X7	95.3 dB	94.2 dB	112.3 dB
X8	95.1 dB	91.6 dB	114.5 dB
X9	92.2 dB	90.3 dB	111.2 dB
X10	91.9 dB	90.0 dB	110.9 dB
X11	93.7 dB	92.0 dB	110.0 dB
X12	94.7 dB	91.8 dB	111.1 dB
X13	96.5 dB	94.6 dB	111.6 dB
X14	94.6 dB	92.8 dB	113.0 dB
X15	90.4 dB	88.8 dB	110.1 dB
X16	92.2 dB	89.9 dB	109.3 dB
X17	94.2 dB	91.1 dB	110.2 dB
X18	93.0 dB	91.3 dB	111.8 dB
X19	95.4 dB	93.9 dB	112.9 dB
X20	94.1 dB	92.6 dB	113.3 dB
X21	90.9 dB	87.5 dB	107.5 dB
X22	95.2 dB	90.7 dB	124.2 dB
X23	101.5 dB	99.1 dB	116.9 dB
X24	102.2 dB	99.4 dB	116.9 dB
X25	102.6 dB	99.4 dB	117.4 dB
X26	92.8 dB	90.3 dB	113.4 dB
X27	108.0 dB	105.2 dB	121.6 dB
X28	109.4 dB	101.6 dB	118.7 dB
X29	108.7 dB	105.2 dB	121.6 dB
X30	112.8 dB	108.4 dB	126.0 dB
X31	102.0 dB	93.1 dB	113.8 dB
X32	106.9 dB	104.0 dB	123.7 dB
X33	99.4 dB	96.3 dB	116.9 dB

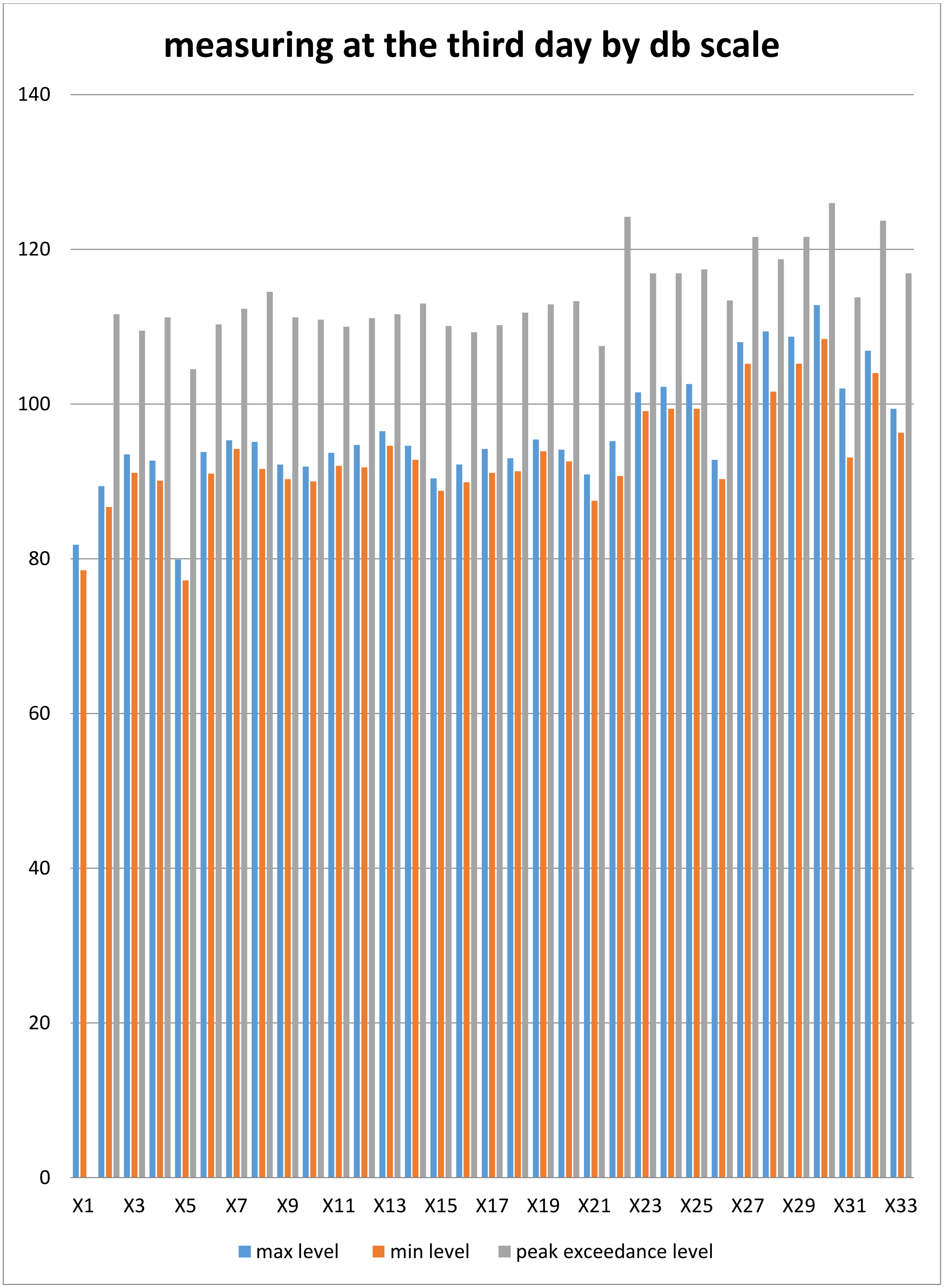


Figure 3.39 Maximum level, minimum level and peak exceedance level by db scale at third day measuring.

3.6.4 Measuring at the forth day

Table (3.5): RMS maximum level (Fast), RMS minimum level (Fast) and Peak exceedance level by db scale at forth day measuring.

Location	RMS maximum level (Fast)	RMS minimum level (Fast)	Peak exceedance level
X1	82.0 dB	80.1 dB	---.- dB
X2	87.1 dB	84.9 dB	106.3 dB
X3	92.5 dB	90.2 dB	110.7 dB
X4	91.5 dB	88.7 dB	111.6 dB
X5	81.0 dB	78.1 dB	---.- dB
X6	92.0 dB	89.5 dB	110.2 dB
X7	93.9 dB	91.7 dB	111.5 dB
X8	93.3 dB	91.7 dB	114.4 dB
X9	90.6 dB	88.8 dB	111.0 dB
X10	91.8 dB	90.1 dB	110.2 dB
X11	94.9 dB	92.7 dB	112.1 dB
X12	94.8 dB	93.2 dB	112.2 dB
X13	96.8 dB	94.9 dB	112.2 dB
X14	94.7 dB	93.0 dB	112.6 dB
X15	90.8 dB	89.5 dB	111.4 dB
X16	89.5 dB	87.7 dB	110.5 dB
X17	91.8 dB	89.5 dB	110.7 dB
X18	90.0 dB	88.3 dB	111.2 dB
X19	92.9 dB	90.7 dB	111.5 dB
X20	92.7 dB	87.6 dB	112.7 dB
X21	92.3 dB	87.3 dB	109.8 dB
X22	95.8 dB	85.2 dB	120.0 dB
X23	100.1 dB	97.7 dB	116.1 dB
X24	101.7 dB	99.4 dB	116.7 dB
X25	102.5 dB	100.2 dB	118.1 dB
X26	93.3 dB	91.2 dB	114.5 dB
X27	108.2 dB	105.9 dB	122.3 dB
X28	110.2 dB	105.4 dB	119.7 dB
X29	110.6 dB	105.6 dB	124.4 dB
X30	113.8 dB	109.5 dB	127.4 dB
X31	101.1 dB	96.2 dB	113.0 dB
X32	107.4 dB	104.8 dB	123.6 dB
X33	101.0 dB	98.2 dB	117.9 dB

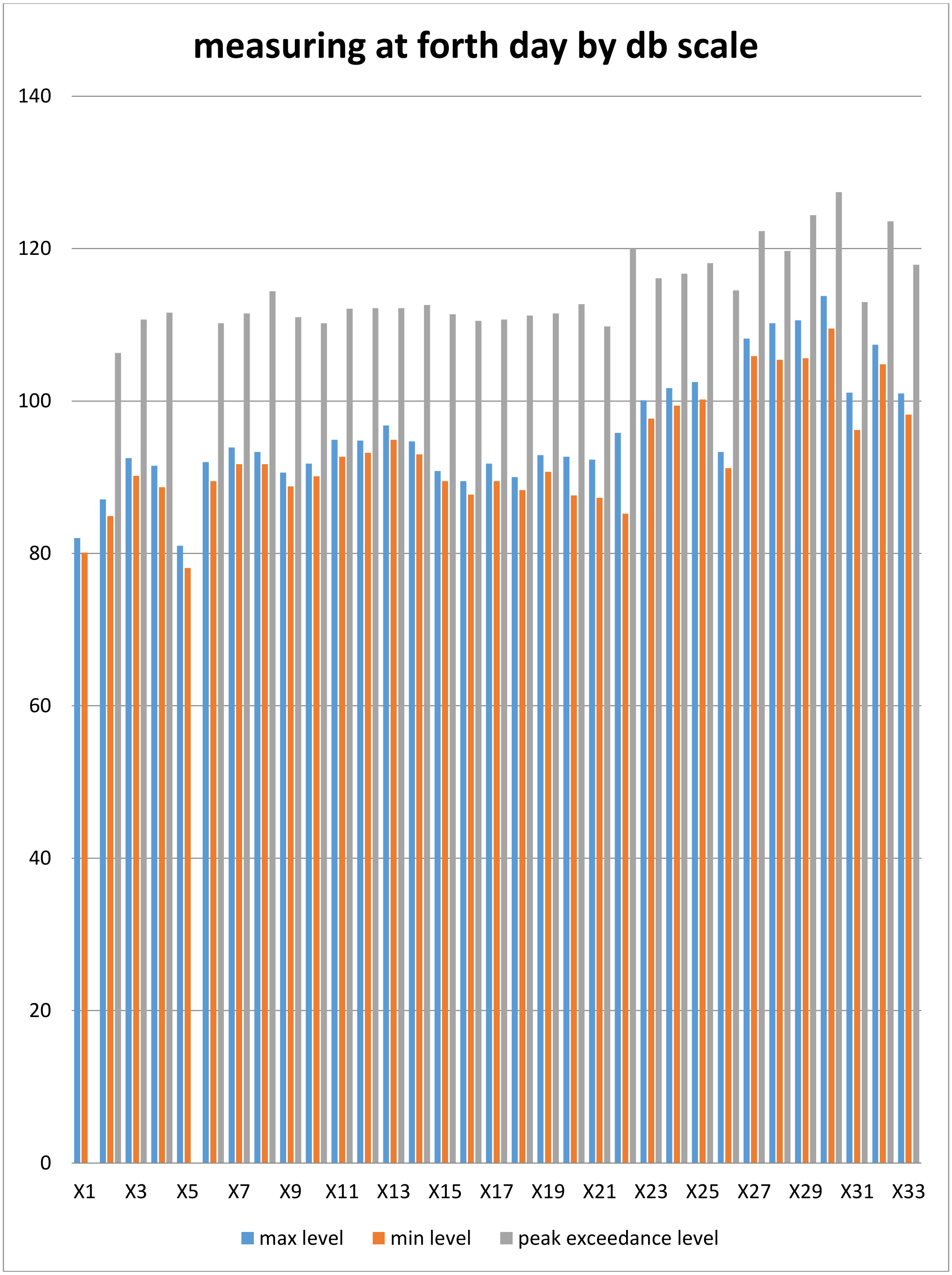


Figure 3.40 Maximum level, minimum level and peak exceedance level by db scale at forth day measuring.

3.6.5 Measuring at the fifth day

Table (3.6): RMS maximum level (Fast), RMS minimum level (Fast) and Peak exceedance level by db scale at fifth day measuring.

Location	RMS maximum level (Fast)	RMS minimum level (Fast)	Peak exceedance level
X1	85.1 dB	80.9 dB	103.8 dB
X2	87.4 dB	85.1 dB	107.4 dB
X3	92.4 dB	90.5 dB	109.7 dB
X4	91.9 dB	89.0 dB	113.0 dB
X5	80.7 dB	78.5 dB	103.2 dB
X6	91.5 dB	89.6 dB	111.7 dB
X7	94.7 dB	92.1 dB	112.6 dB
X8	93.1 dB	91.1 dB	113.9 dB
X9	90.8 dB	89.1 dB	111.5 dB
X10	92.3 dB	90.2 dB	109.7 dB
X11	95.4 dB	93.3 dB	112.0 dB
X12	94.9 dB	93.1 dB	110.9 dB
X13	96.6 dB	94.8 dB	111.8 dB
X14	96.4 dB	93.2 dB	112.5 dB
X15	90.5 dB	88.8 dB	110.3 dB
X16	89.2 dB	87.6 dB	109.7 dB
X17	92.4 dB	89.6 dB	110.5 dB
X18	90.1 dB	88.5 dB	111.3 dB
X19	92.6 dB	91.1 dB	112.1 dB
X20	93.8 dB	90.2 dB	116.2 dB
X21	90.6 dB	87.5 dB	109.8 dB
X22	95.7 dB	91.9 dB	117.8 dB
X23	102.2 dB	98.3 dB	117.6 dB
X24	102.6 dB	99.3 dB	117.2 dB
X25	103.2 dB	100.3 dB	118.0 dB
X26	93.1 dB	90.7 dB	114.0 dB
X27	108.5 dB	105.5 dB	121.9 dB
X28	107.9 dB	102.1 dB	118.5 dB
X29	112.0 dB	107.6 dB	126.0 dB
X30	112.3 dB	109.1 dB	126.4 dB
X31	98.3 dB	93.6 dB	112.3 dB
X32	106.7 dB	104.8 dB	123.2 dB
X33	99.8 dB	97.7 dB	117.4 dB

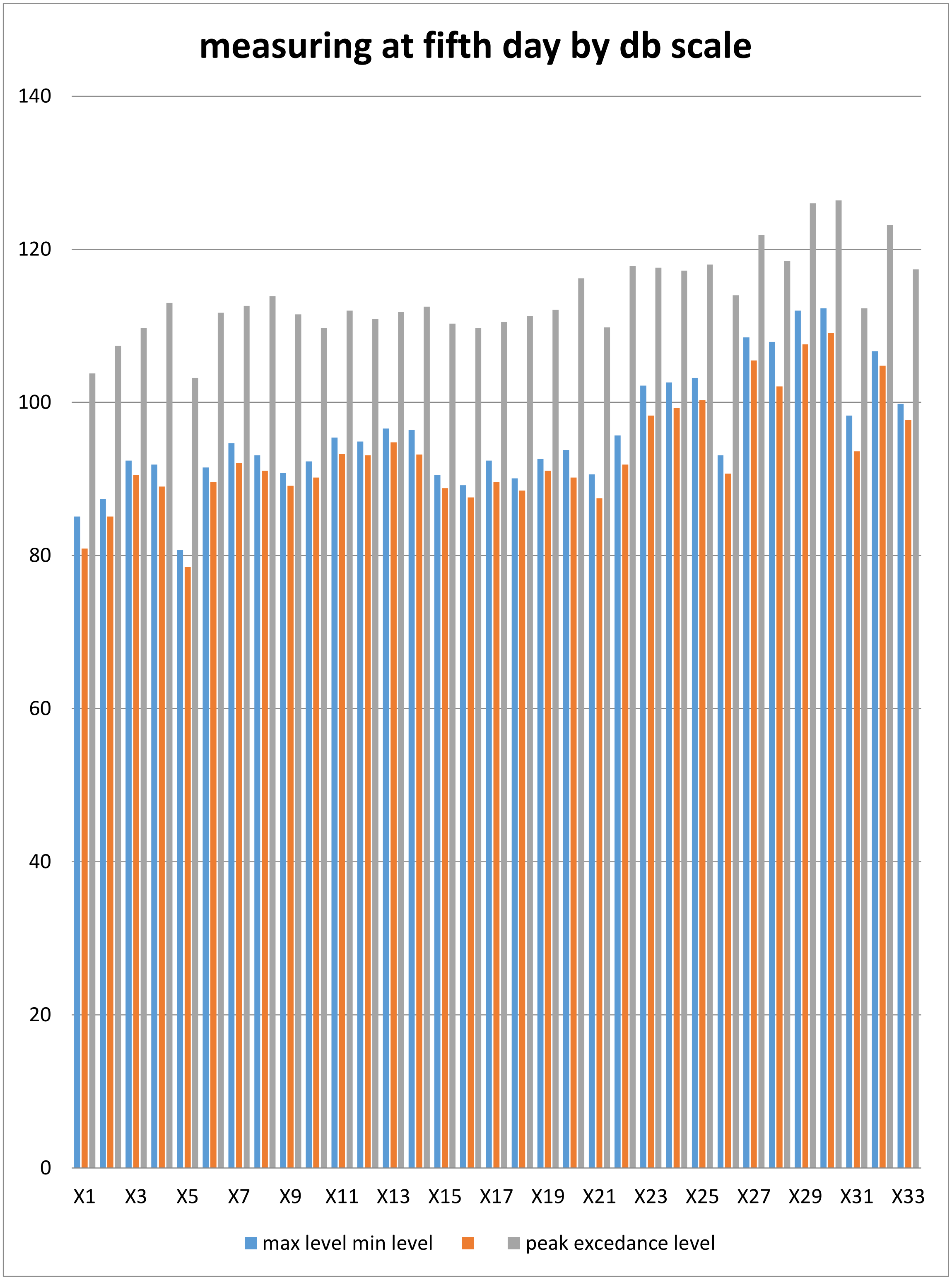


Figure 3.41 Maximum level, minimum level and peak exceedance level by db scale at fifth day measuring.

Chapter 4

ANALYSIS, DISCUSSION AND RESULT

4.1 Analysis

It is illustrated that from the results an analysis, to all location which determine in this area and make comparing with OSAH stander, and considering

We will analyze the results which has been taken from specific sites in question, and taking into account the average maximum level readings of all readings recorded in five days by the noise level meter device. The measuring device record the reading of each site for five minutes period at each point. During the five minutes the noise device record the maximum, minimum and peak exceedance levels. We will choosing the average maximum level sound from five days at all location and compare it to with OSHA standard in order to find out the permitted noise for working period and not permitted. The average db for each location has been found in detail in appendix (1) for one location. Similar dbs can be found by the same.

The following figures from fig(4.1) to fig(4.33) shown the measurement of each location and the calculation of the average.

4.1.1 Steam turbine unit (3)

4.1.1 .1 Location X1(at low pressure feed pump, STU3)

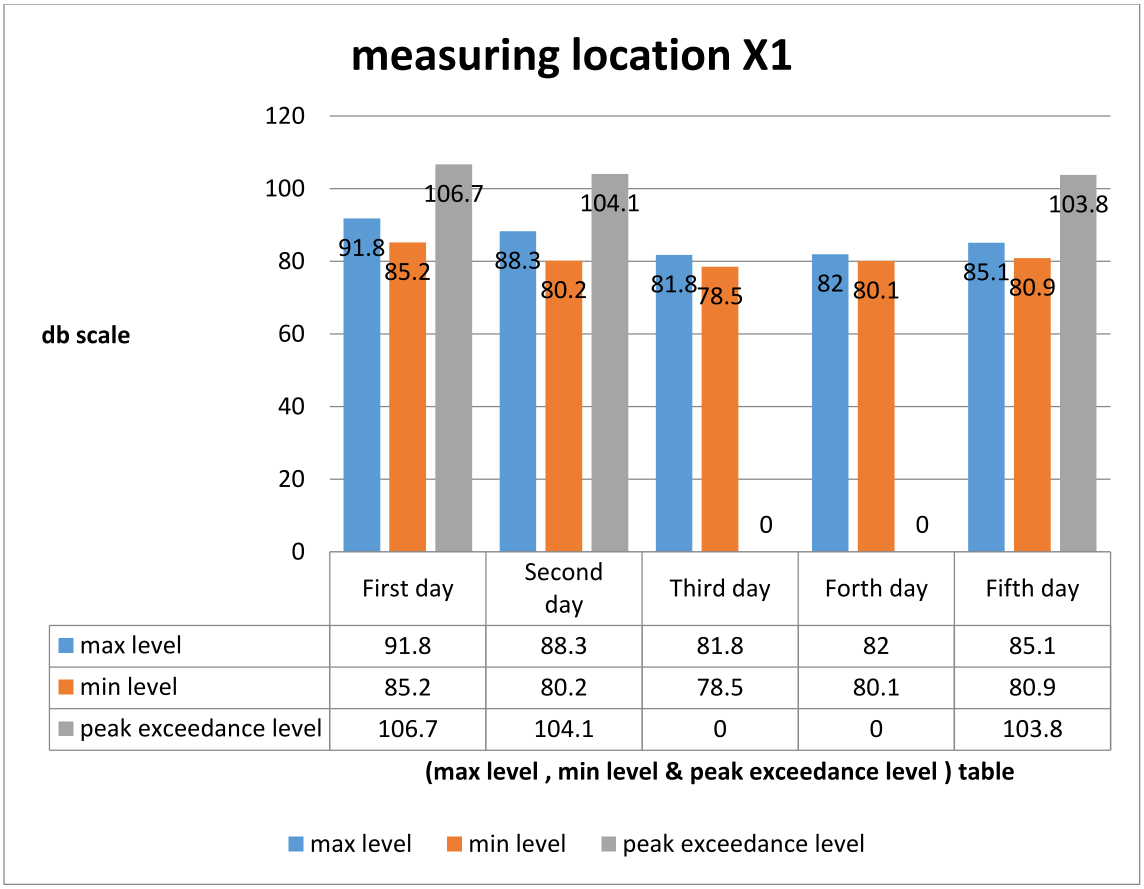


Figure 4.1 Max, min and peak exceedance level at location X1,STU3.

$$X'max = \frac{91.8 + 88.3 + 81.8 + 82 + 85.1}{5}$$

$$X'1max = 85.8\ dbA$$

$$X'min = \frac{85.2 + 80.2 + 78.5 + 80.1 + 80.9}{5}$$

$$X'1min = 80.98\ dbA$$

4.1.1.2 Location X2 (at the door of unit, STU3)

	First day	Second day	Third day	Forth day	Fifth day
max level	89.8	89.7	89.4	87.1	87.4
min level	79.9	85.4	86.7	84.9	85.1
peak exceedance	0	107.3	111.6	106.3	107.4

Figure 4.2 Max , min and peak exceedance level at location X2,STU3.

$$X'2max = \frac{89.8 + 89.7 + 89.4 + 87.1 + 87.4}{5}$$

$$X'2max = 88.68\ dbA$$

$$X'2min = \frac{79.9 + 85.4 + 86.7 + 84.9 + 85.1}{5}$$

$$X'2min = 84.4\ dbA$$

4.1.1.3 Location X3 (4,20 m from X2 inside the unit, STU3)

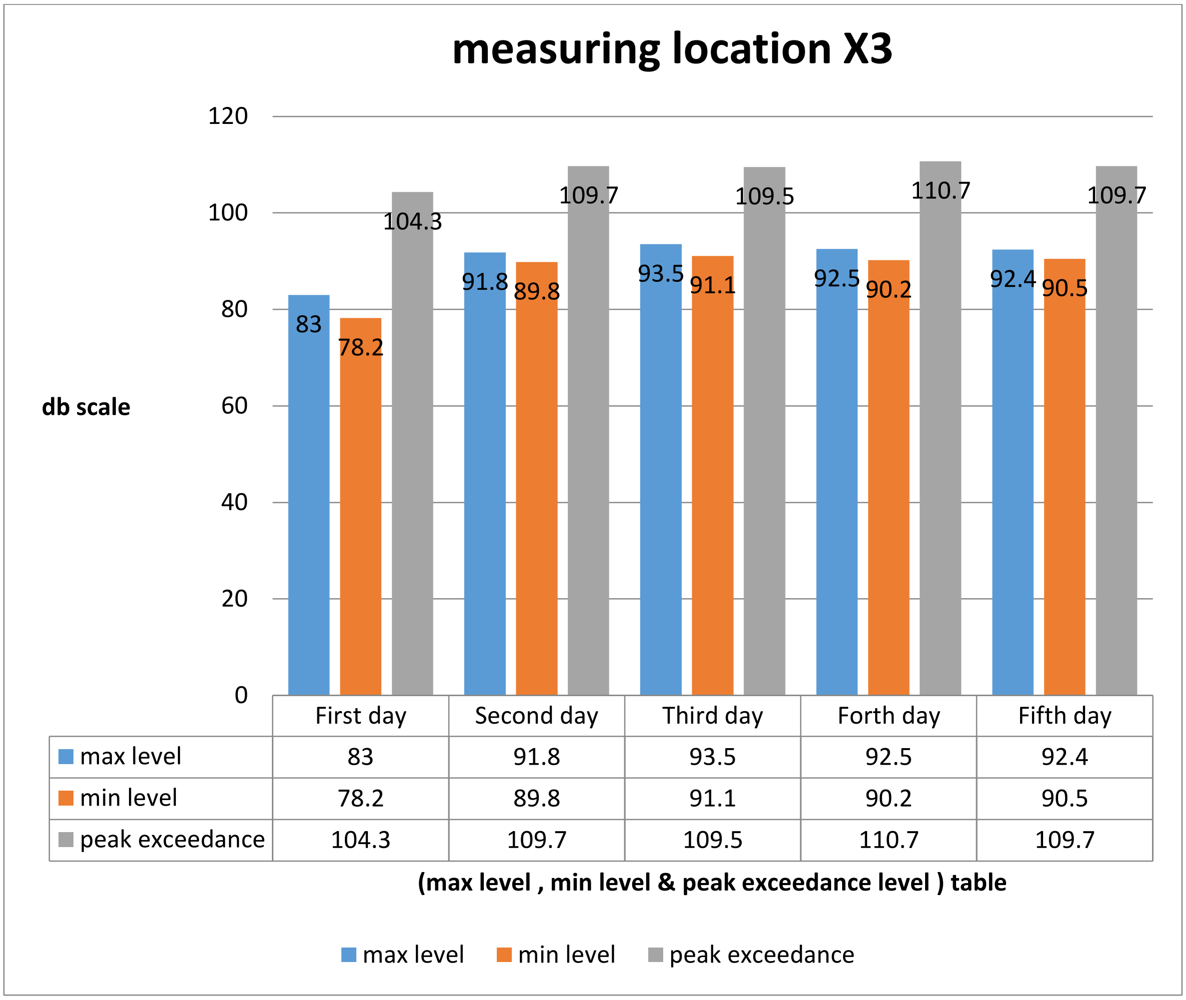


Figure 4.3 Max, min and peak exceedance level at location X3,STU3.

$$X'3max = \frac{83 + 91.8 + 93.5 + 92.5 + 92.4}{5}$$

$$X'3max = 90.64\ db\ A$$

$$X'3min = \frac{78.2 + 89.8 + 91.1 + 90.2 + 90.5}{5}$$

$$X'3min = 87.96\ dbA$$

4.1.1.4 Location X4 (6 m from X2 outside the unit, STU3)

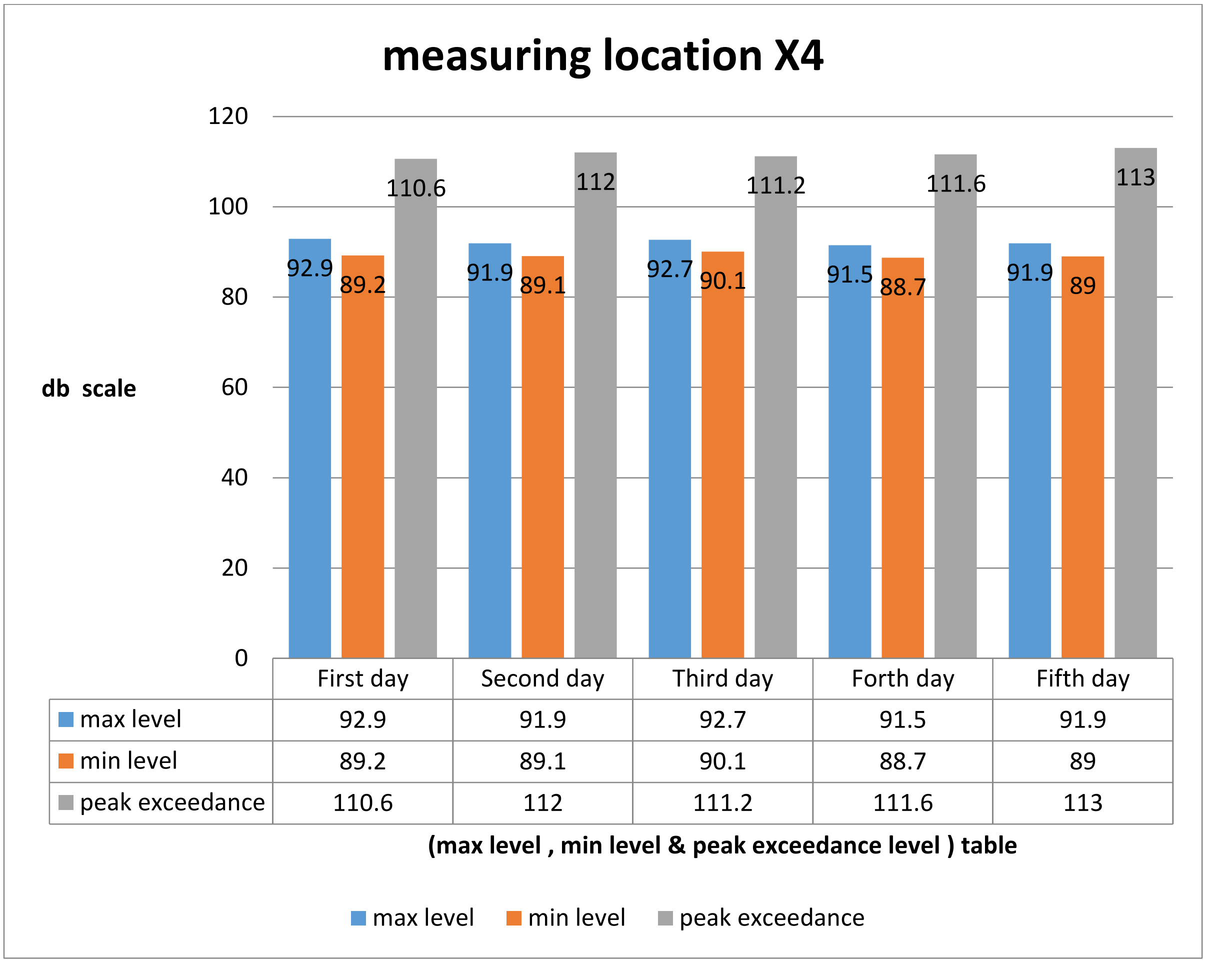


Figure 4.4 Max, min and peak exceedance level at location X4, STU3.

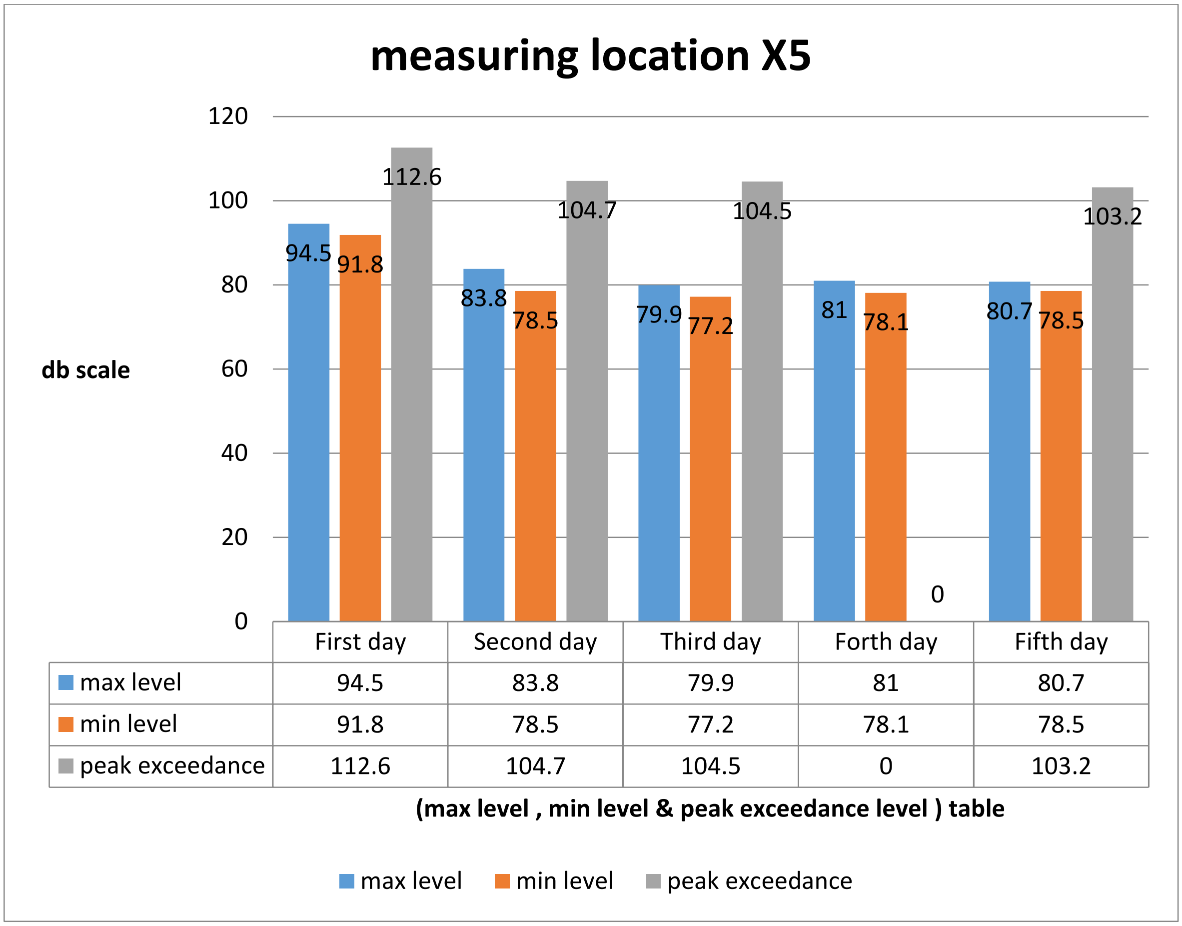
$$X'4max = \frac{92.9 + 91.9 + 92.7 + 91.5 + 91.9}{5}$$

$$X'4max = 92.18\ db\ A$$

$$X'4min = \frac{89.2 + 89.1 + 90.1 + 88.7 + 89}{5}$$

$$X'4min = 89.22\ dbA$$

4.1.1.5 Location X5 (13 m from X2 outside unit, STU3)



	First day	Second day	Third day	Forth day	Fifth day
max level	94.5	83.8	79.9	81	80.7
min level	91.8	78.5	77.2	78.1	78.5
peak exceedance	112.6	104.7	104.5	0	103.2

Figure 4.5 Max, min and peak exceedance at location X5, STU3.

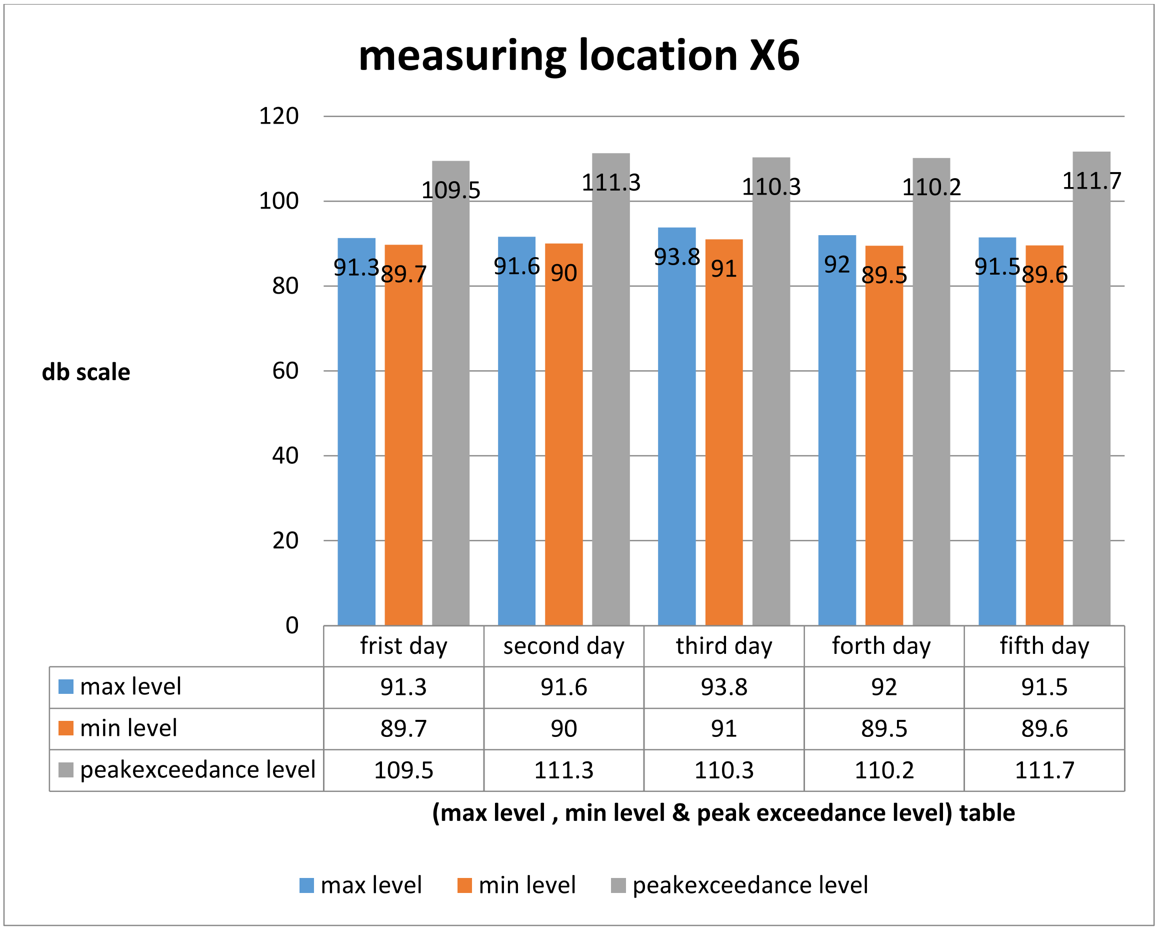
$$X'5max = \frac{94.5 + 83.8 + 79.9 + 81 + 80.7}{5}$$

$$X'5max = 83.98\ db\ A$$

$$X'5min = \frac{91.8 + 78.5 + 77.2 + 78.1 + 78.5}{5}$$

$$X'5min = 80.82\ dbA$$

4.1.1.6 Location X6 (at high pressure feed pump, STU3)



	frist day	second day	third day	forth day	fifth day
max level	91.3	91.6	93.8	92	91.5
min level	89.7	90	91	89.5	89.6
peakexceedance level	109.5	111.3	110.3	110.2	111.7

Figure 4.6 Max, min and peak exceedance level at location X6, STU3.

$$X'6max = \frac{91.3 + 91.6 + 93.8 + 92 + 91.5}{5}$$

$$X'6max = 92.04\ db\ A$$

$$X'6min = \frac{89.7 + 90 + 91 + 89.5 + 89.6}{5}$$

$$X'6min = 89.96\ dbA$$

4.1.1.7 Location X7 (between two noise source X6 and X8, STU3)

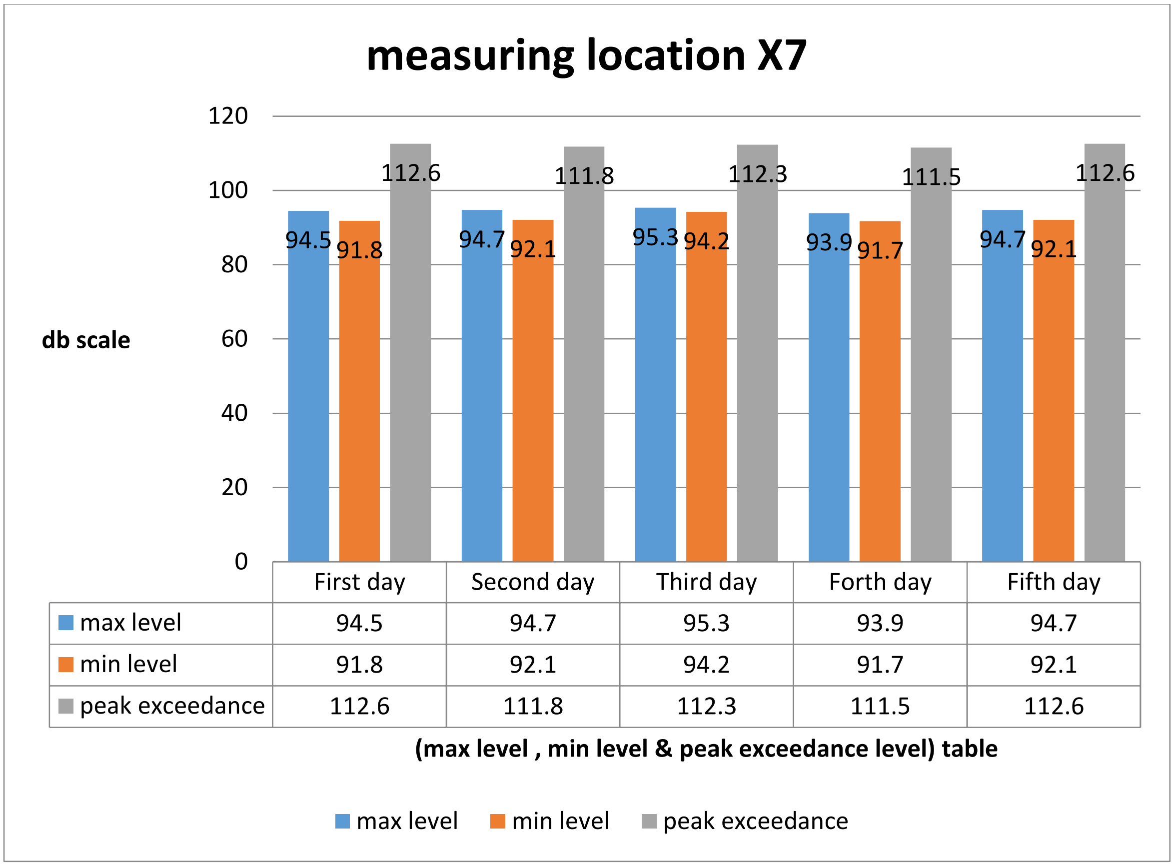


Figure 4.7 Max, min and peak exceedance level at location X7, STU3.

$$X'7max = \frac{94.5 + 94.7 + 95.3 + 93.9 + 94.7}{5}$$

$$X'7max = 94.62\ db\ A$$

$$X'7min = \frac{91.8 + 92.1 + 94.2 + 91.7 + 92.1}{5}$$

$$X'7min = 92.38\ dbA$$

4.1.1.8 Location X8 (at steam turbine, STU3)

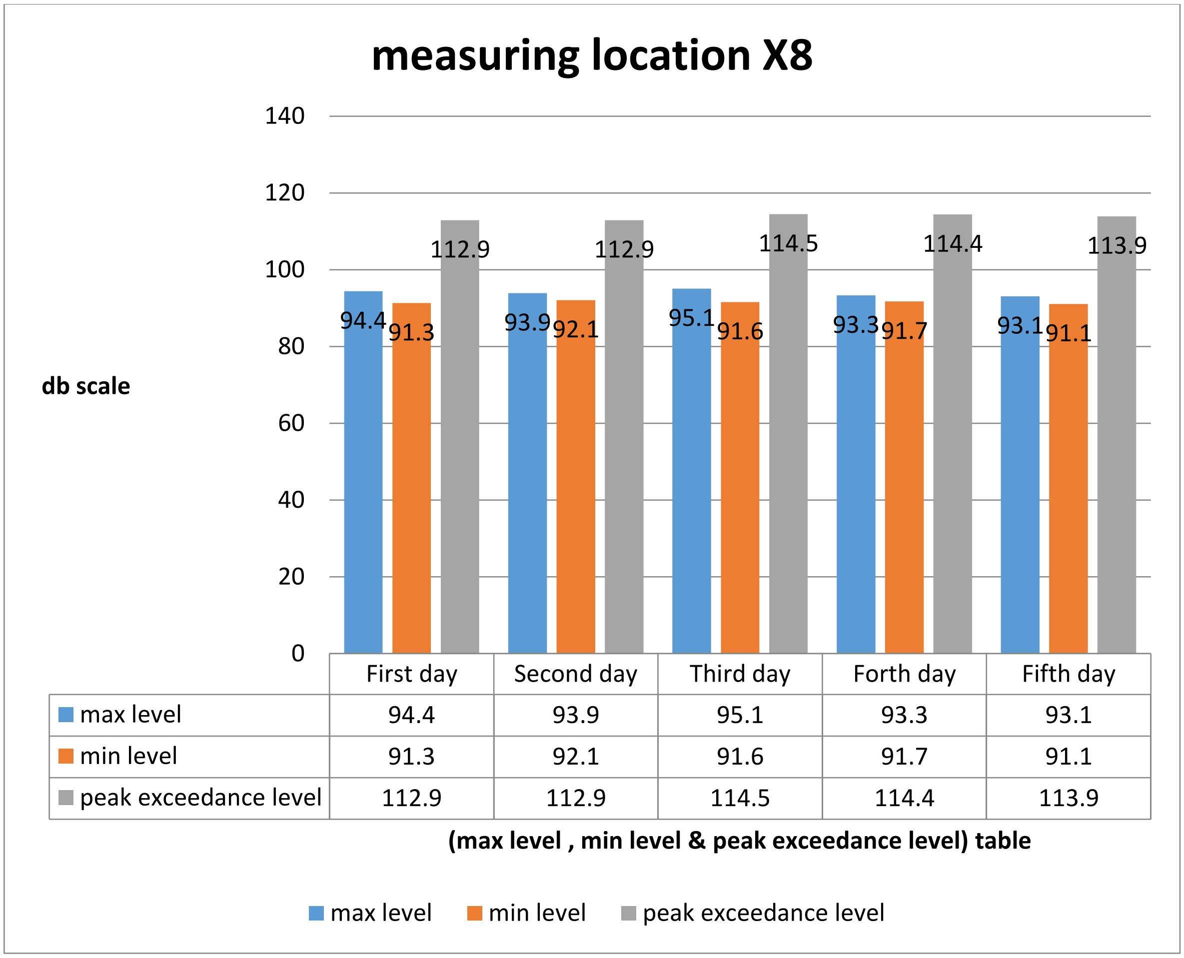


Figure 4.8 Max, min and peak exceedance level by at location X8, STU3.

$$X'8max = \frac{94.4 + 93.9 + 95.1 + 93.9 + 93.1}{5}$$

$$X'8max = 93.96\ db\ A$$

$$X'8min = \frac{91.3 + 92.1 + 91.6 + 91.7 + 91.1}{5}$$

$$X'8min = 91.56\ db$$

4.1.1.9 Location X9 (at generator, STU3)

Figure 4.9 Max, min and peak exceedance level at location X9, STU3.

$$X'9max = \frac{90.9 + 91.3 + 92.2 + 90.6 + 90.8}{5}$$

$$X'9max = 91.16\ db\ A$$

$$X'9min = \frac{89 + 88.9 + 90.3 + 88.8 + 89.1}{5}$$

$$X'9min = 89.22\ dbA$$

4.1.2 Steam turbine unit (2)

4.1 .2.1 Location X10 (at low pressure feed water pump, STU2)

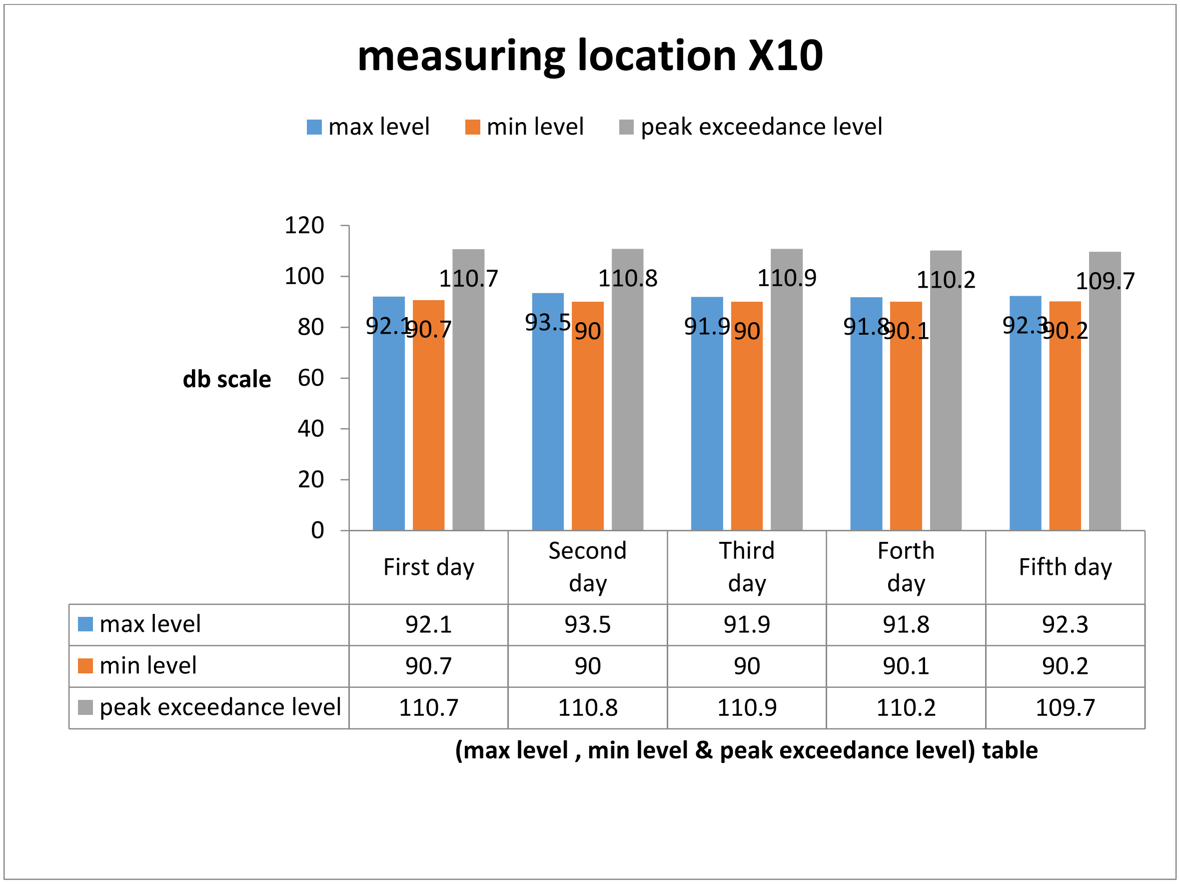


Figure 4.10 max, min and peak exceedance level at location X10, STU2.

$$X'10max = \frac{92.1 + 93.5 + 91.9 + 91.8 + 92.8}{5}$$

$$X'10max = 92.42\ db\ A$$

$$X'10min = \frac{90.7 + 90 + 90 + 90.1 + 90.2}{5}$$

$$X'10min = 90.2\ dbA$$

4.1.2.2 Location X11 (at high pressure feed water pump, STU2)

	First day	Second day	Third day	Forth day	Fifth day
max level	95.2	95.8	93.7	94.9	95.4
min level	92.8	94.1	92	92.7	93.3
peak exceedance level	111.7	112	110	112.1	112

Figure 4.11 max, min and peak exceedance level at location X11, STU2.

$$X'11max = \frac{95.2 + 95.8 + 93.7 + 94.9 + 95.4}{5}$$

$$X'11max = 95\ db\ A$$

$$X'11min = \frac{92.8 + 94.1 + 92 + 92.7 + 93.3}{5}$$

$$\mathrm{X'11min = 92.98\ dbA}$$

4.1.2.3 Location X12 (between two noise source X11 and X13, STU2)

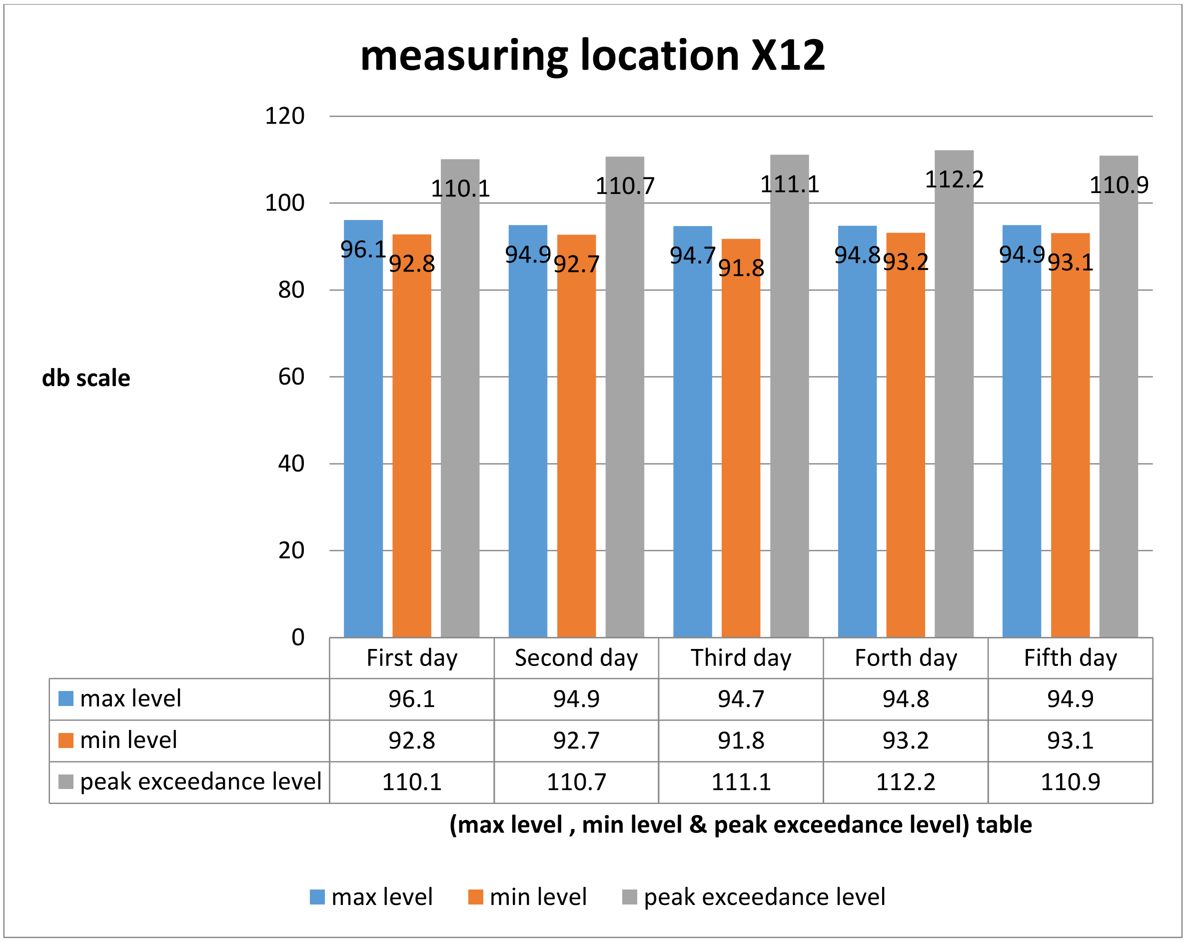


Figure 4.12 Max, min and peak exceedance level at location X12, STU2.

$$X'12max = \frac{96.1 + 94.9 + 94.7 + 94.8 + 95.9}{5}$$

$$X'12max = 95.08\ db\ A$$

$$X'12min = \frac{92.8 + 92.7 + 91.8 + 93.2 + 93.1}{5}$$

$$X'12min = 92.72\ dbA$$

4.1.2.4 Location X13 (at steam turbine, STU2)

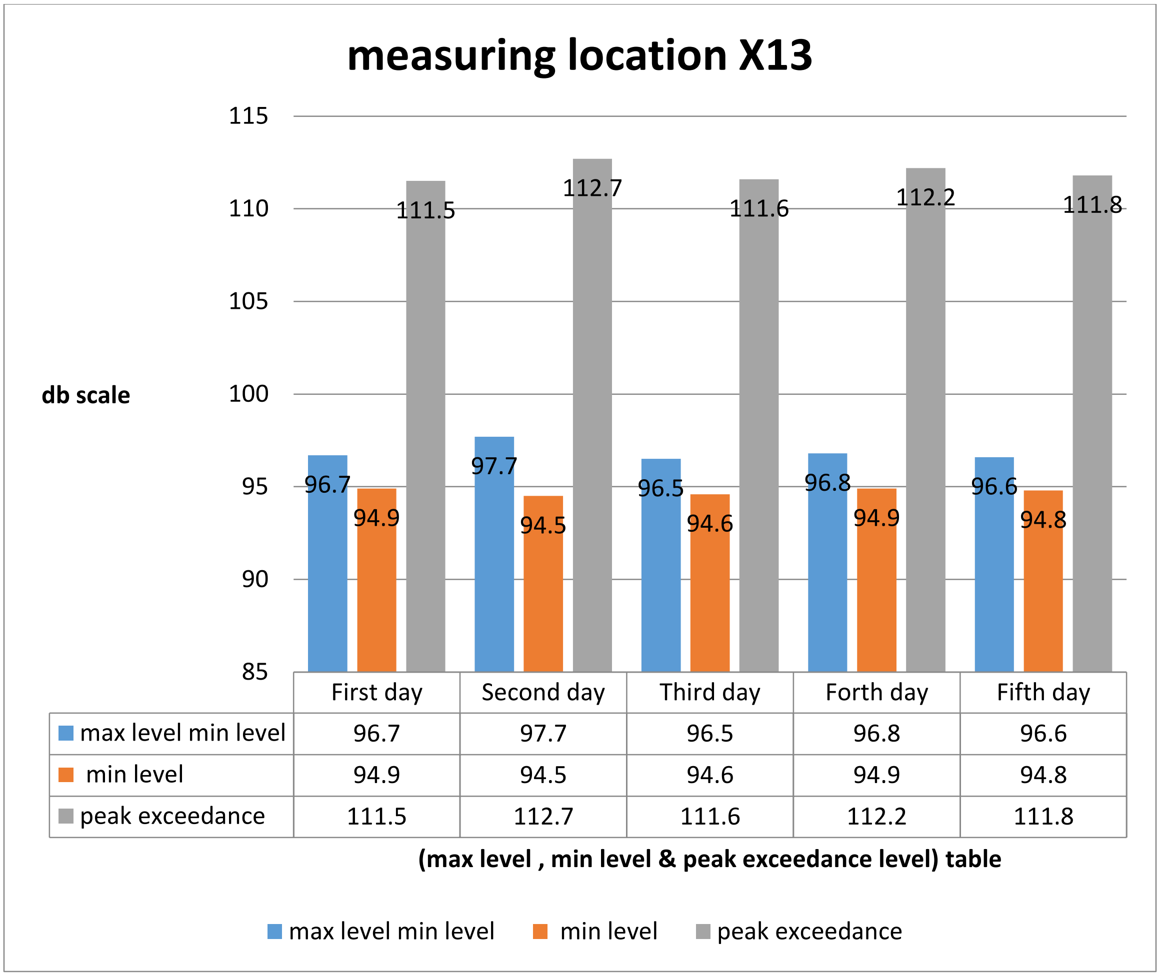


Figure 4.13 Max, min and peak exceedance level at location X13,STU2.

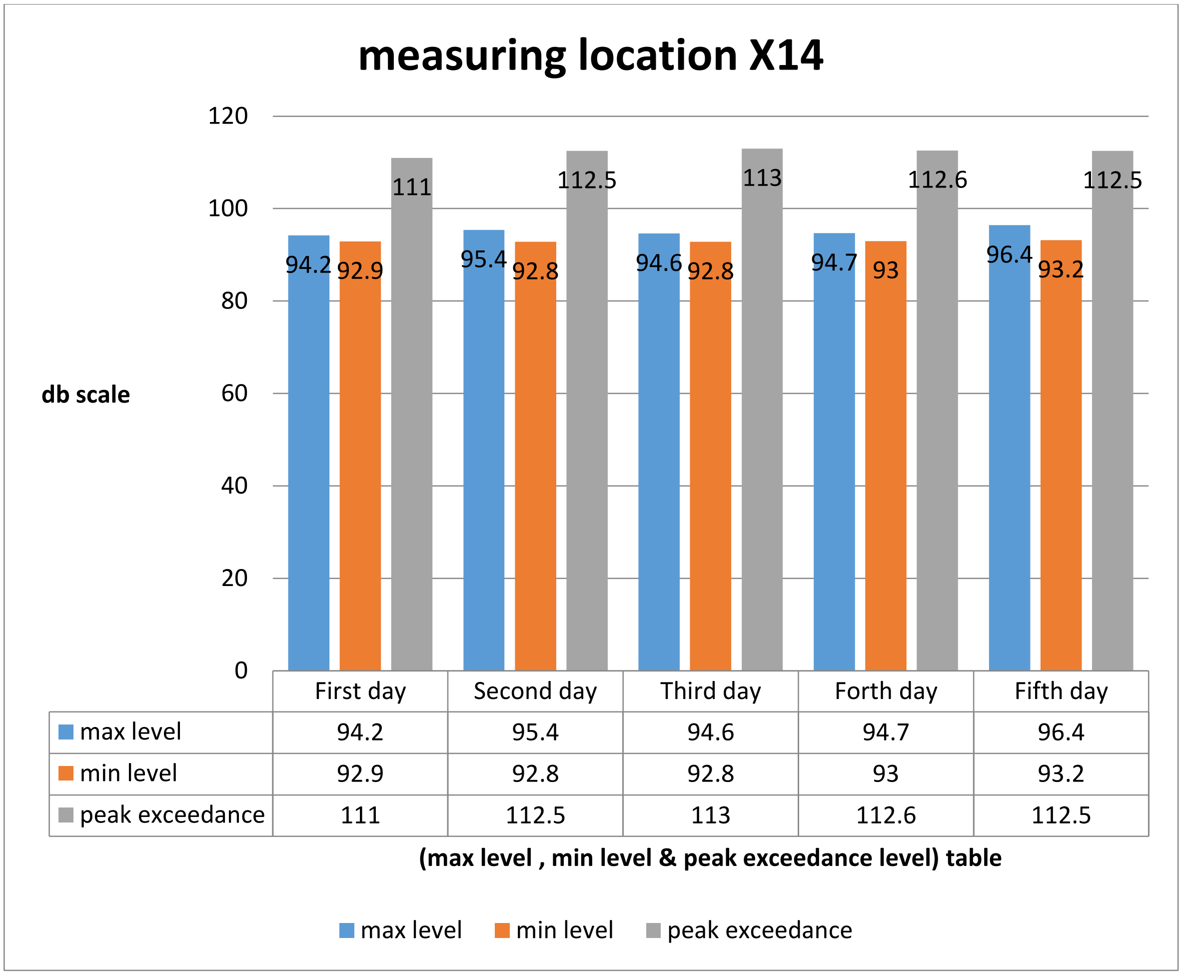
$$X'13max = \frac{96.7 + 97.7 + 96.5 + 96.8 + 96.6}{5}$$

$$X'13max = 96.86\ db\ A$$

$$X'13min = \frac{94.7 + 94.5 + 94.6 + 94.9 + 94.8}{5}$$

$$X'13min = 94.7\ dbA$$

4.1.2.5 Location X14 (at generator, STU2)



	First day	Second day	Third day	Forth day	Fifth day
max level	94.2	95.4	94.6	94.7	96.4
min level	92.9	92.8	92.8	93	93.2
peak exceedance	111	112.5	113	112.6	112.5

Figure 4.14 Max, min and peak exceedance level at location X14, STU2.

$$X'14max = \frac{94.2 + 95.4 + 94.6 + 94.7 + 96.4}{5}$$

$$X'14max = 95.06db\ A$$

$$X'14min = \frac{92.9 + 92.8 + 92.8 + 93 + 93.2}{5}$$

$$X'14min = 92.94\ db$$

4.1.2.6 Location X15 (between two noise source, Generator and lube oil system, STU2)

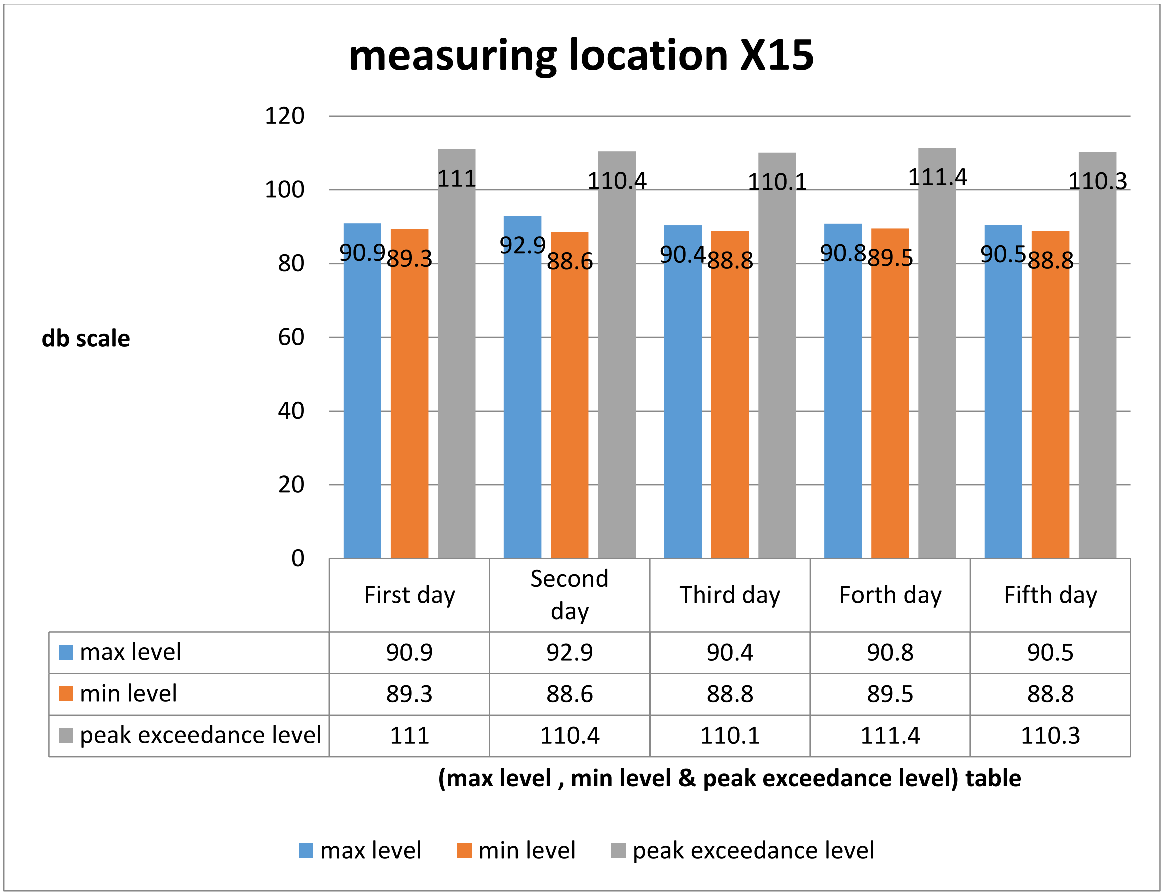


Figure 4.15 Max, min and peak exceedance level at location X15, STU2.

$$X'15\text{max} = \frac{90.9 + 92.9 + 90.4 + 90.8 + 90.5}{5}$$

$$X'15\text{max} = 91.1 \text{ db A}$$

$$X'15\text{min} = \frac{89.3 + 88.6 + 88.8 + 89.5 + 88.8}{5}$$

$$X'15\text{min} = 89 \text{ dbA}$$

4.1.3 steam turbine unit (1)

4.1.3.1 Location X16 (at low pressure feed water pump, STU1)

Figure 4.16 Max, min and peak exceedance level at location X16, STU1.

$$X'16max = \frac{89.3 + 89.4 + 92.2 + 89.5 + 89.2}{5}$$

$$X'16max = 89.92 \text{ db A}$$

$$X'16min = \frac{87.6 + 87.4 + 89.9 + 87.7 + 87.6}{5}$$

$$X'16min = 88.04 \text{ dbA}$$

4.1.3.2 Location X17 (at high pressure feed water pump, STU1)

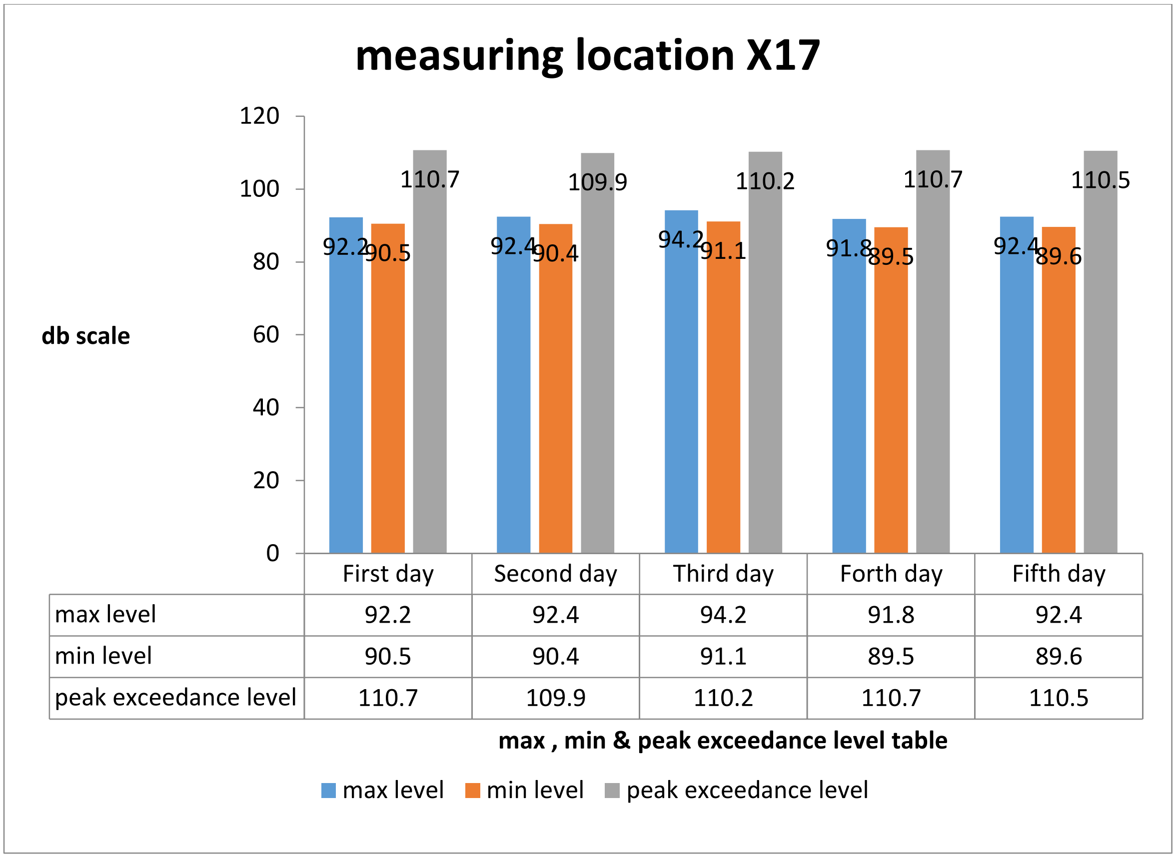


Figure 4.17 Max, min and peak exceedance level at location X17, STU1.

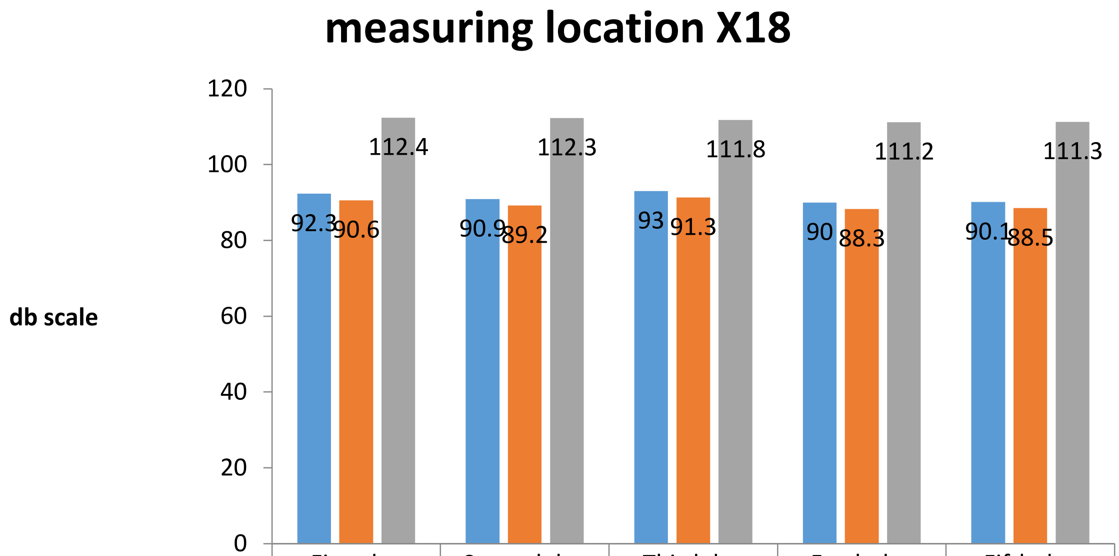
$$X'17\text{max} = \frac{92.2 + 92.4 + 94.2 + 91.8 + 92.4}{5}$$

$$X'17\text{max} = 92.6 \text{ db A}$$

$$X'17\text{min} = \frac{90.5 + 90.4 + 91.1 + 89.5 + 89.6}{5}$$

$$X'17\text{min} = 90.22 \text{ dbA}$$

4.1.3.3 Location X18 (between two noise source X17 and X19, STU1)



	First day	Second day	Third day	Forth day	Fifth day
max level	92.3	90.9	93	90	90.1
min level	90.6	89.2	91.3	88.3	88.5
peak exceedance level	112.4	112.3	111.8	111.2	111.3

(max level , min level & peak exceedance level) table

Figure 4.18 Max, min and peak exceedance level at location X18, STU1.

$$X'18max = \frac{92.3 + 90.9 + 93 + 90 + 90.1}{5}$$

$$X'18max = 91.26 \text{ db A}$$

$$X'18min = \frac{90.6 + 89.2 + 91.3 + 88.3 + 88.5}{5}$$

$$X'18min = 89.58 \text{ dbA}$$

4.1.3.4 Location X19 (at steam turbine, STU1)

	First day	Second day	Third day	Forth day	Fifth day
max level	93.5	91.9	95.4	92.9	92.6
min level	92.2	90.2	93.9	90.7	91.1
peak exceedance level	113	111.5	112.9	111.5	112.1

Figure 4.19 Max, min and peak exceedance level at location X19, STU1.

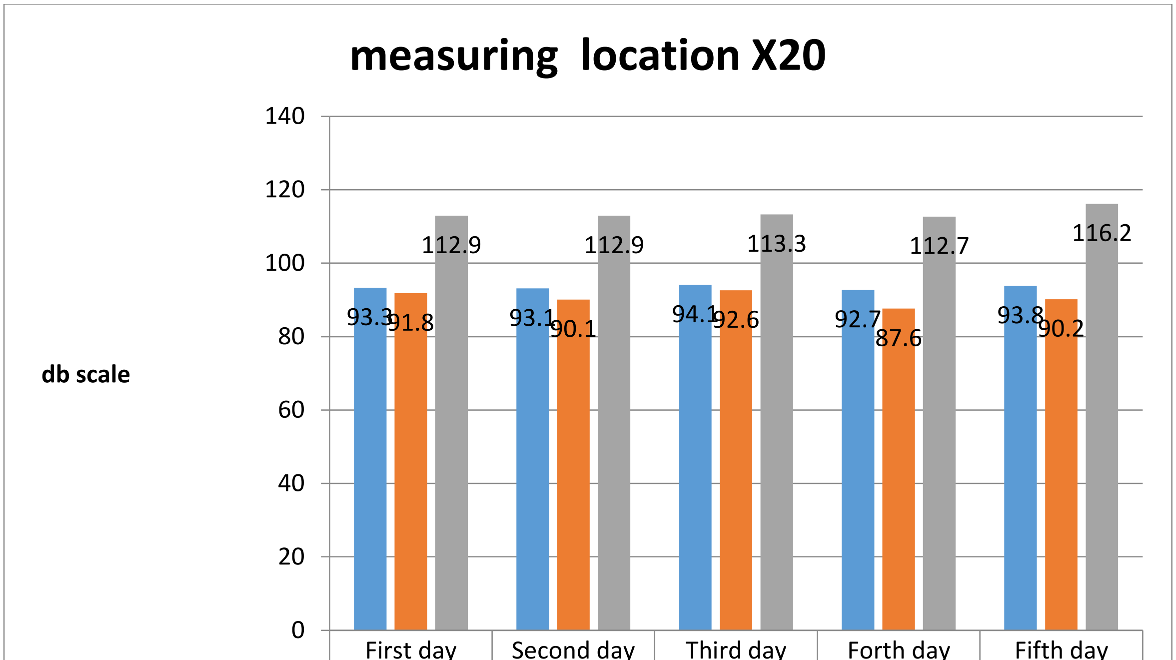
$$X'19max = \frac{93.5 + 91.9 + 95.4 + 92.9 + 92.6}{5}$$

$$X'19max = 93.26 \text{ db A}$$

$$X'19min = \frac{92.2 + 90.2 + 93.9 + 90.7 + 91.1}{5}$$

$$X'19min = 91.62 \text{ db}$$

4.1.3.5 Location X20 (at generator, STU1)



	First day	Second day	Third day	Forth day	Fifth day
max level	93.3	93.1	94.1	92.7	93.8
min level	91.8	90.1	92.6	87.6	90.2
peak exceedance level	112.9	112.9	113.3	112.7	116.2

Figure 4.20 Max, min and peak exceedance level at location X20, STU1.

$$X'20\text{max} = \frac{93.3 + 93.1 + 94.1 + 92.7 + 93.8}{5}$$

$$X'20\text{max} = 93.4 \text{ db A}$$

$$X'20\text{min} = \frac{91.8 + 90.1 + 92.6 + 87.6 + 90.2}{5}$$

$$X'20\text{min} = 90.46 \text{ dbA}$$

4.1.3.6 Location X21 (between two noise source generator and lube oil system, STU1)

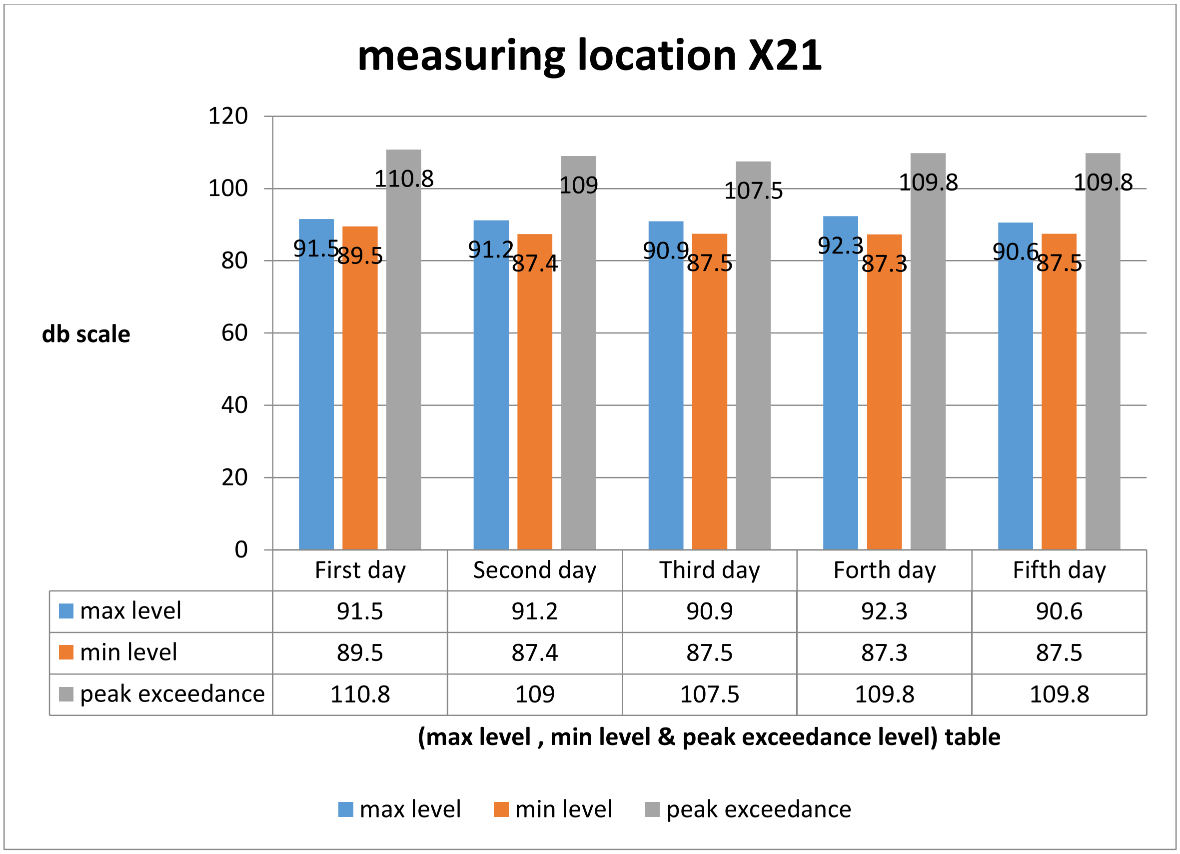


Figure 4.21 Max, min and peak exceedance level at location X21, STU1.

$$X'21\text{max} = \frac{91.5 + 91.2 + 90.9 + 92.3 + 90.6}{5}$$

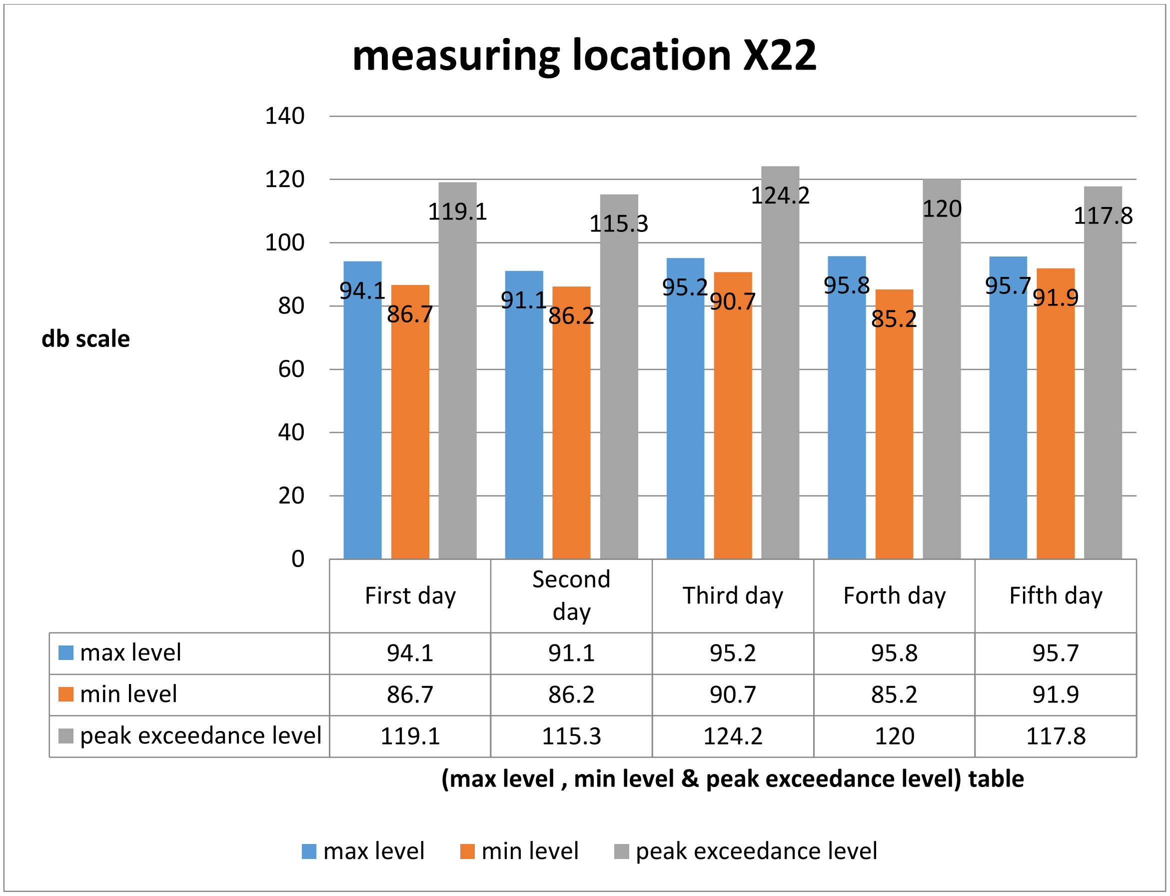
$$X'21\text{max} = 91.36 \text{ db A}$$

$$X'21\text{min} = \frac{89.5 + 87.4 + 87.5 + 87.3 + 87.5}{5}$$

$$X'21\text{min} = 87.84 \text{ dbA}$$

4.1.4 cooler system unit(CSU)

4.1.4.1 Location X22 (at cooler water CSU)



	First day	Second day	Third day	Forth day	Fifth day
max level	94.1	91.1	95.2	95.8	95.7
min level	86.7	86.2	90.7	85.2	91.9
peak exceedance level	119.1	115.3	124.2	120	117.8

Figure 4.22 Max, min and peak exceedance level at location X22, CSU.

$$X'22max = \frac{94.1 + 91.1 + 95.2 + 95.8 + 95.7}{5}$$

$$X'22max = 94.38 \text{ db A}$$

$$X'22min = \frac{86.7 + 86.2 + 90.7 + 85.2 + 91.9}{5}$$

$$X'22min = 88.14 \text{ db}$$

4.1.5 fuel forwarding pump unit(FFPU)

4.1.5.1 Location X23 (at the door fuel forwarding pump, FFPU)

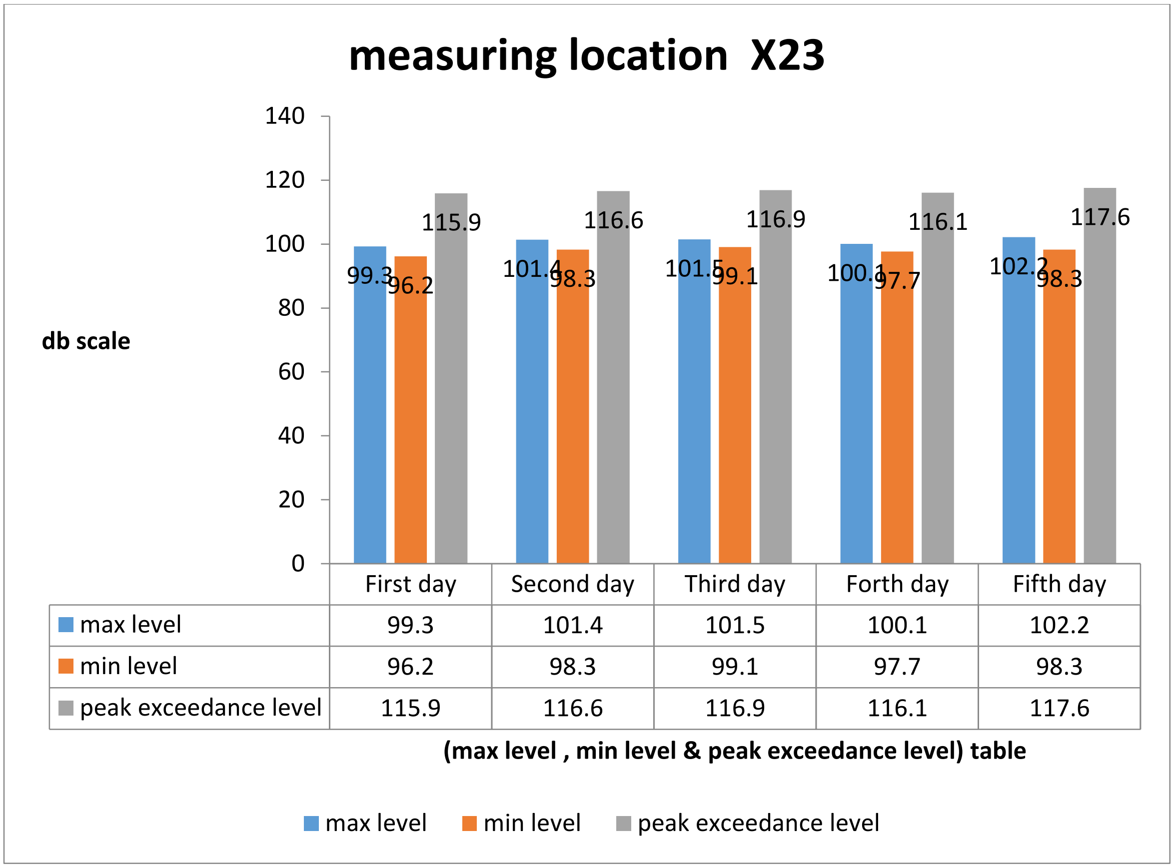


Figure 4.23 Max, min and peak exceedance level at location X23, FFPU.

$$X'23max = \frac{99.3 + 101.4 + 101.5 + 100.1 + 102.2}{5}$$

$$X'23max = 100.9 \text{ db A}$$

$$X'23min = \frac{96.2 + 98.3 + 99.1 + 97.7 + 98.3}{5}$$

$$X'23min = 97.92 \text{ dbA}$$

4.1.5.2 Location X24 (4,20 m from X23 inside the room, FFPU)

Figure 4.24 Max, min and peak exceedance at location X24, FFPU.

$$X'24max = \frac{101.2 + 102.2 + 102.2 + 101.7 + 102.6}{5}$$

$$X'24max = 102.18 \text{ db A}$$

$$X'24min = \frac{99 + 99.4 + 99.4 + 99.4 + 99.3}{5}$$

$$X'24min = 99.3 \text{ dbA}$$

4.1.5.3 Location X25 (4,30 m from X24, FFPU)

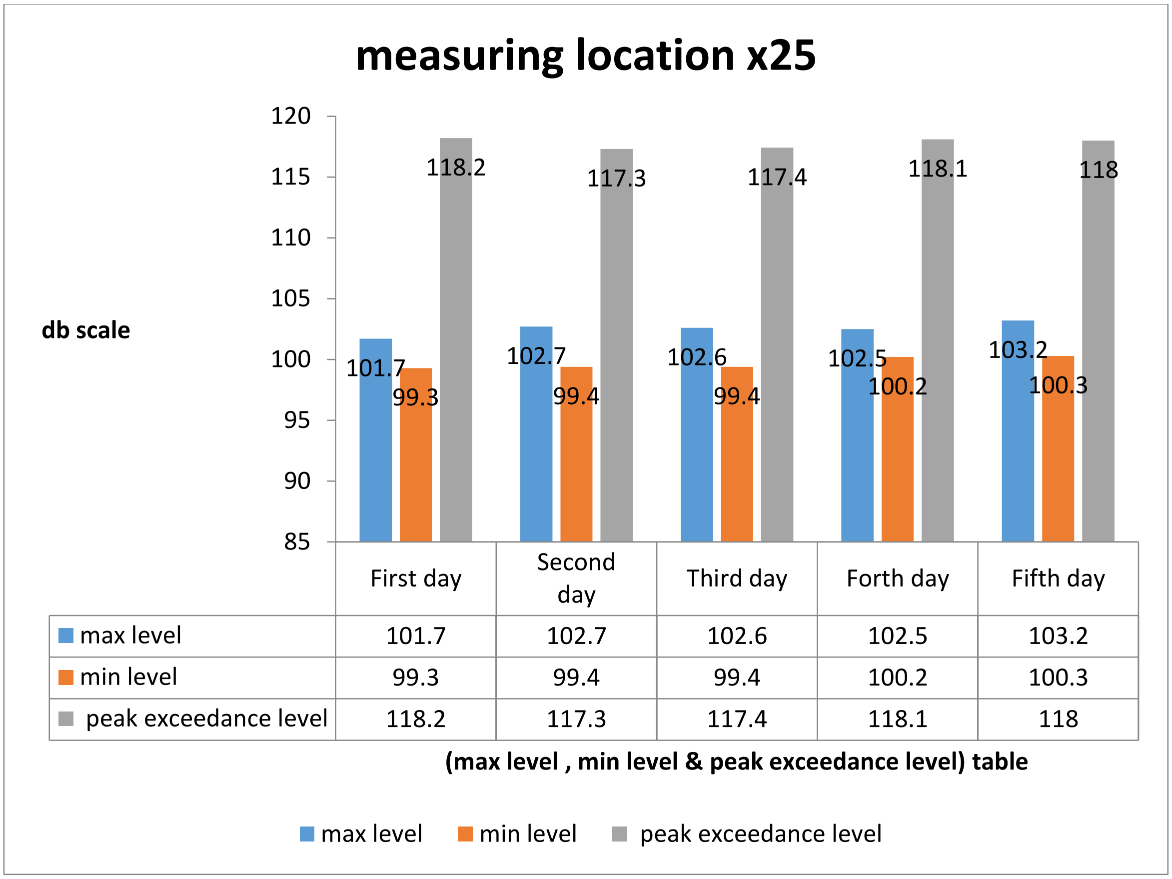


Figure 4.25 Max, min and peak exceedance level at location X25, FFPU.

$$X'25max = \frac{101.7 + 102.7 + 102.6 + 102.5 + 103.2}{5}$$

$$X'25max = 102.54 \text{ db A}$$

$$X'25min = \frac{99.3 + 99.4 + 99.4 + 100.2 + 100.3}{5}$$

$$X'25min = 99.72 \text{ dbA}$$

4.1.6 Gas turbine unit (14), GTU14.

4.1.6.1 Location X26 (at auxiliary boiler room, GTU14)

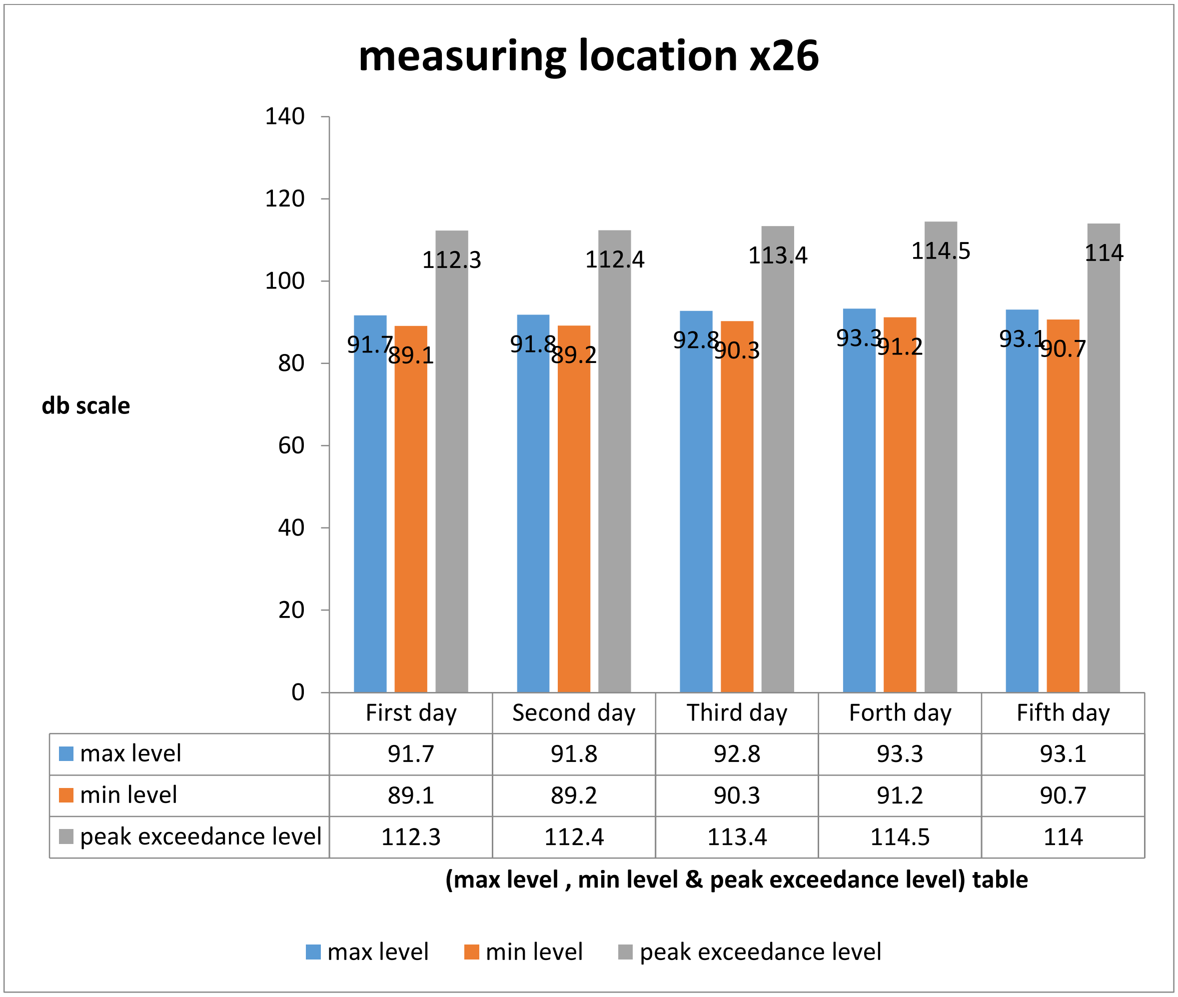


Figure 4.26 Max, min and peak exceedance level at location X26, GTU14.

$$X'26max = \frac{91.7 + 91.8 + 92.8 + 93.3 + 93.1}{5}$$

$$X'26max = 92.48 \text{ db A}$$

$$X'26min = \frac{89.1 + 89.2 + 90.3 + 91.2 + 90.7}{5}$$

$$X'26min = 90.1 \text{ dbA}$$

4.1.6.2 Location X27 (inside lube oil system room, GTU14)

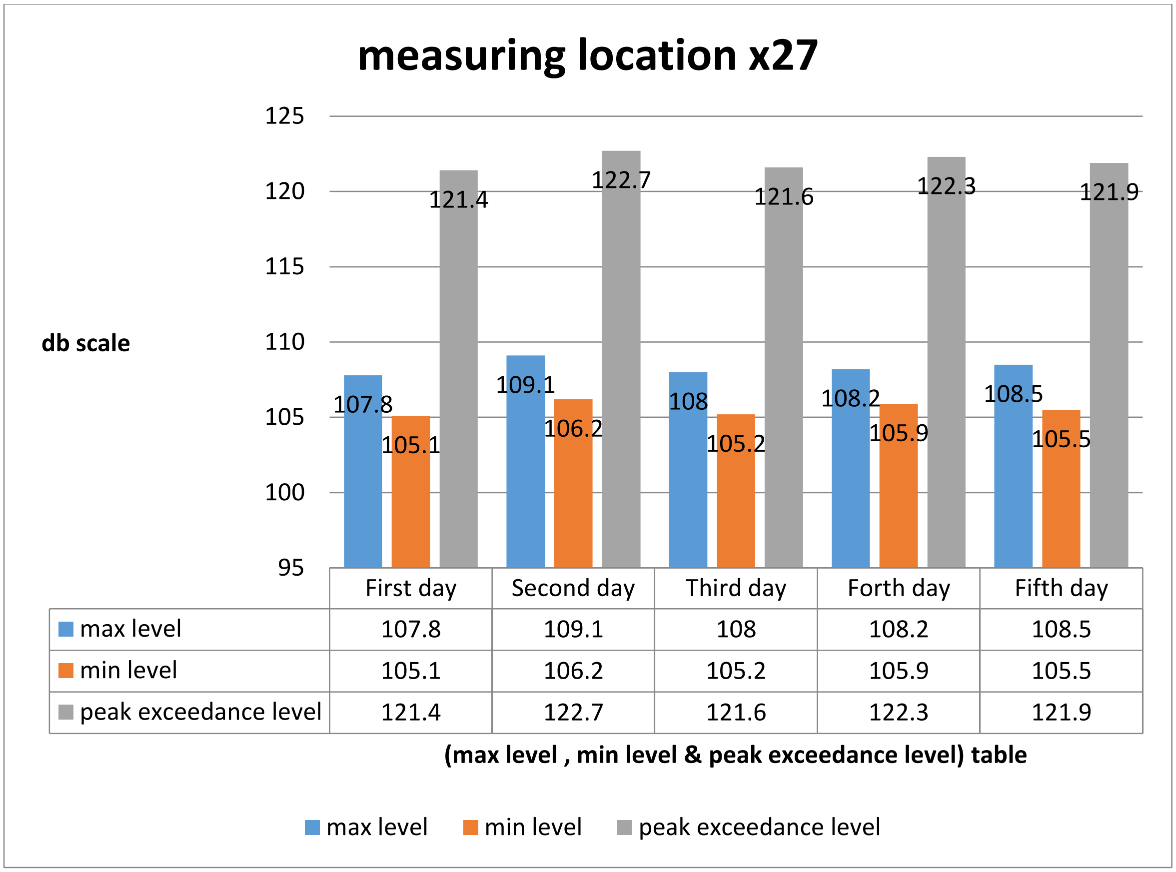


Figure 4.27 Max, min and peak exceedance level at location X27, GTU14.

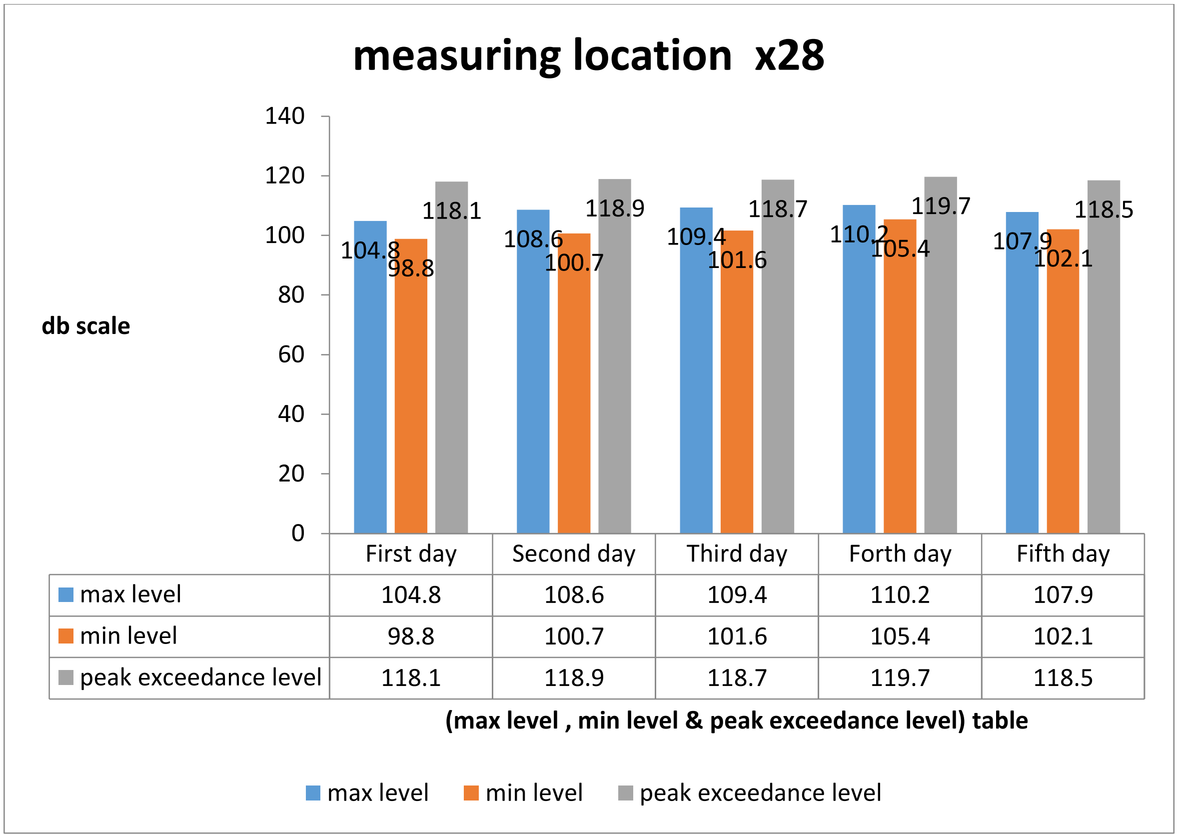
$$X'27max = \frac{107.8 + 109.1 + 108 + 108.2 + 108.5}{5}$$

$$X'27max = 108.32 \text{ db A}$$

$$X'27min = \frac{105.1 + 106.2 + 105.2 + 105.9 + 105.5}{5}$$

$$X'27min = 105.58 \text{ dbA}$$

4.1.6.3 Location X28 (at variable inlet gaud vane room, GTU14)



	First day	Second day	Third day	Forth day	Fifth day
max level	104.8	108.6	109.4	110.2	107.9
min level	98.8	100.7	101.6	105.4	102.1
peak exceedance level	118.1	118.9	118.7	119.7	118.5

Figure 4.28 Max, min and peak exceedance level at location X28, GTU14.

$$X'28max = \frac{104.8 + 108.6 + 109.4 + 110.2 + 107.9}{5}$$

$$X'28max = 108.18 \text{ db A}$$

$$X'28min = \frac{98.8 + 100.7 + 101.6 + 105.4 + 102.1}{5}$$

$$X'28min = 101.72 \text{ dbA}$$

4.1.6.4 Location X29 (at the door (1) to trust bearing joint room between compressor and generator, GTU14)

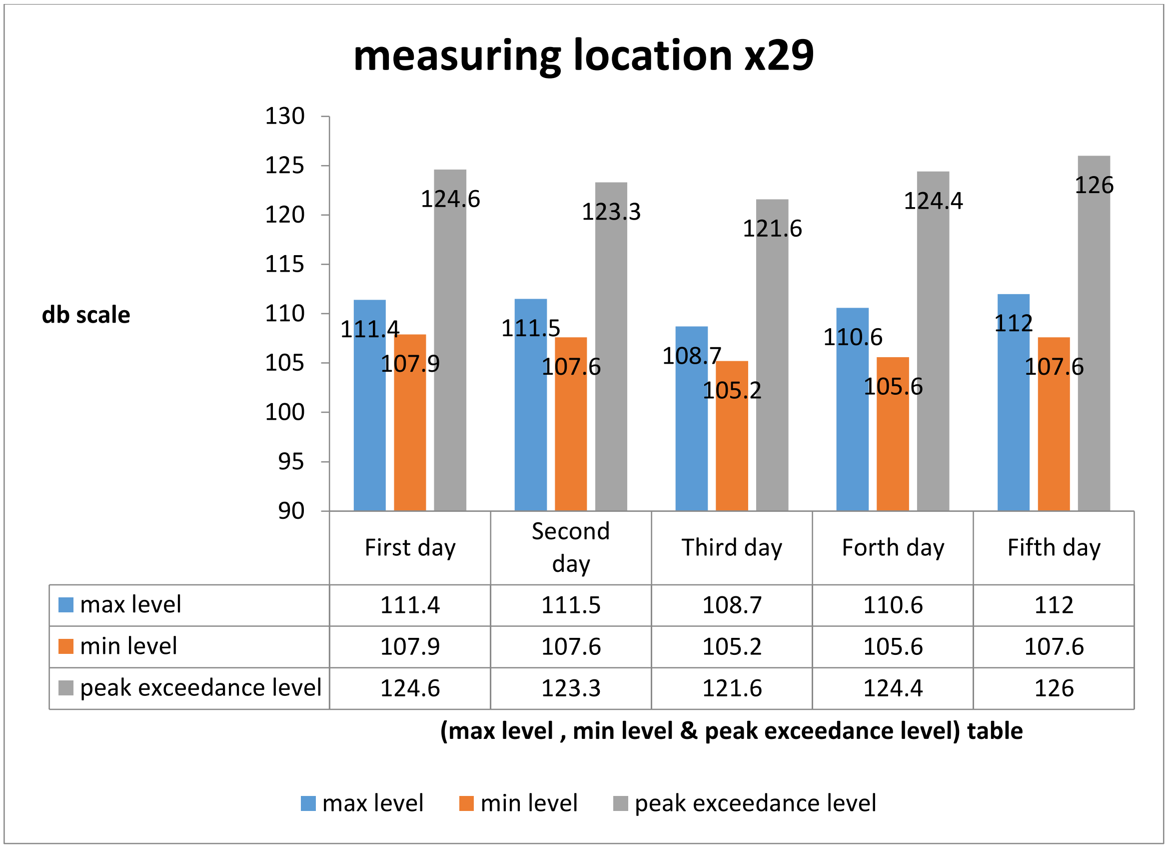


Figure 4.29 Max, min and peak exceedance level at location X29, GTU14.

$$X'29\text{max} = \frac{111.4 + 111.5 + 108.7 + 110.6 + 112}{5}$$

$$X'29\text{max} = 110.84 \text{ db A}$$

$$X'29\text{min} = \frac{107.9 + 107.6 + 105.2 + 105.6 + 107.6}{5}$$

$$X'29\text{min} = 106.78 \text{ dbA}$$

4.1.6.5 X30 Location (at the door (2) to trust bearing joint room between compressor and generator, GTU14)

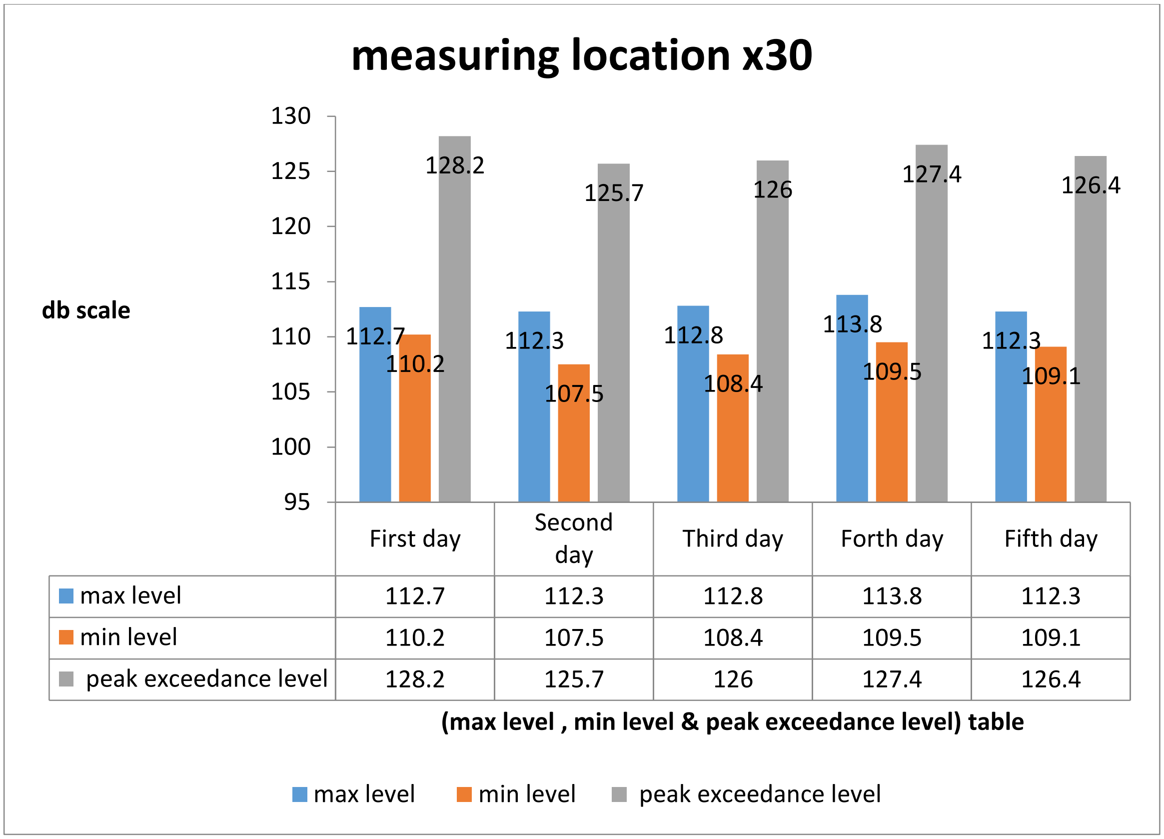


Figure 4.30 Max, min and peak exceedance level at location X30, GTU14.

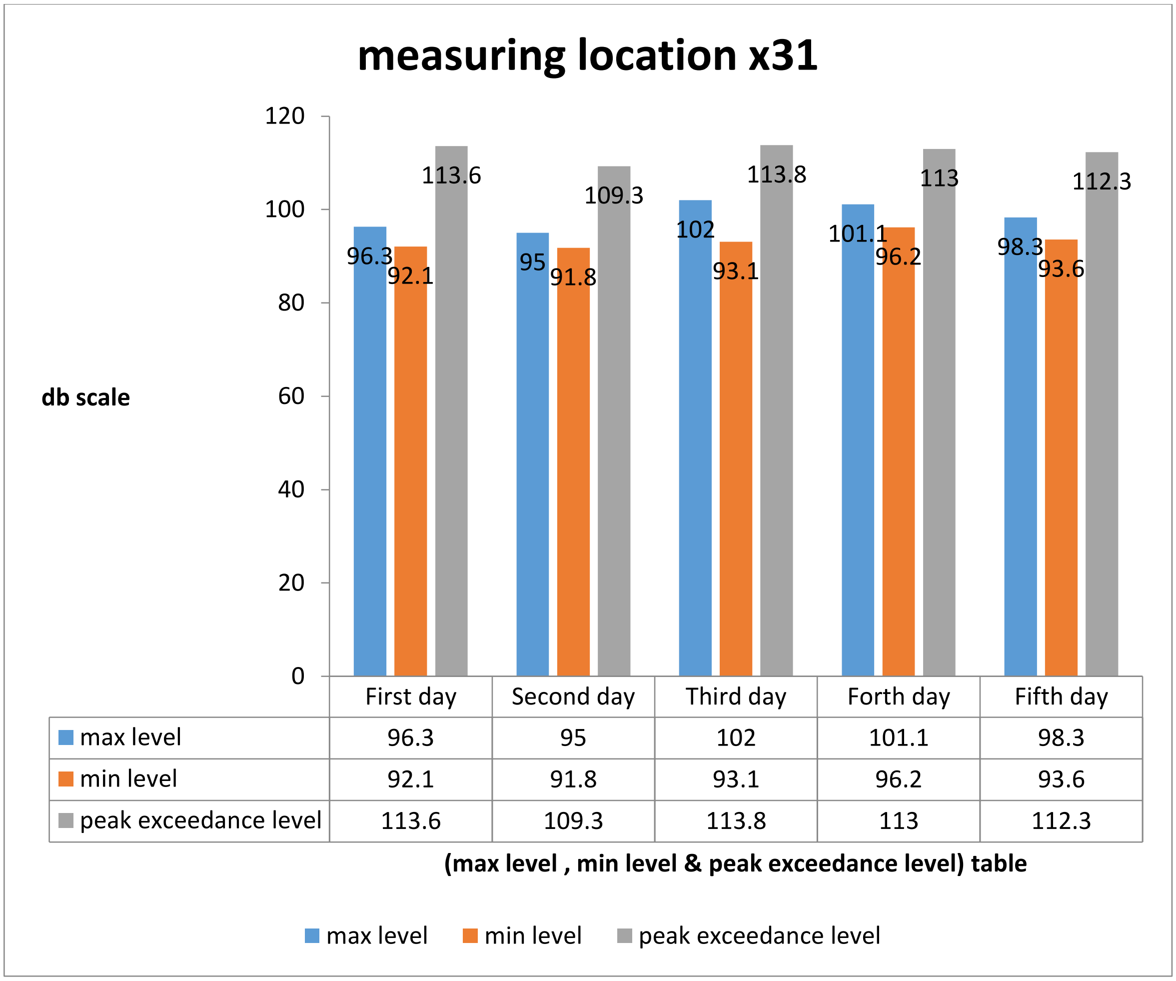
$$X'30\text{max} = \frac{112.7 + 112.3 + 112.8 + 113.8 + 112.3}{5}$$

$$X'30\text{max} = 112.8 \text{ db A}$$

$$X'30\text{min} = \frac{110.2 + 107.5 + 108.4 + 109.5 + 109.1}{5}$$

$$X'30\text{min} = 108.94 \text{ dbA}$$

4.1.6.6 X31 Location (at the door gas turbine room, GTU14)



	First day	Second day	Third day	Forth day	Fifth day
max level	96.3	95	102	101.1	98.3
min level	92.1	91.8	93.1	96.2	93.6
peak exceedance level	113.6	109.3	113.8	113	112.3

Figure 4.31 Max, min and peak exceedance level at location X31, GTU14.

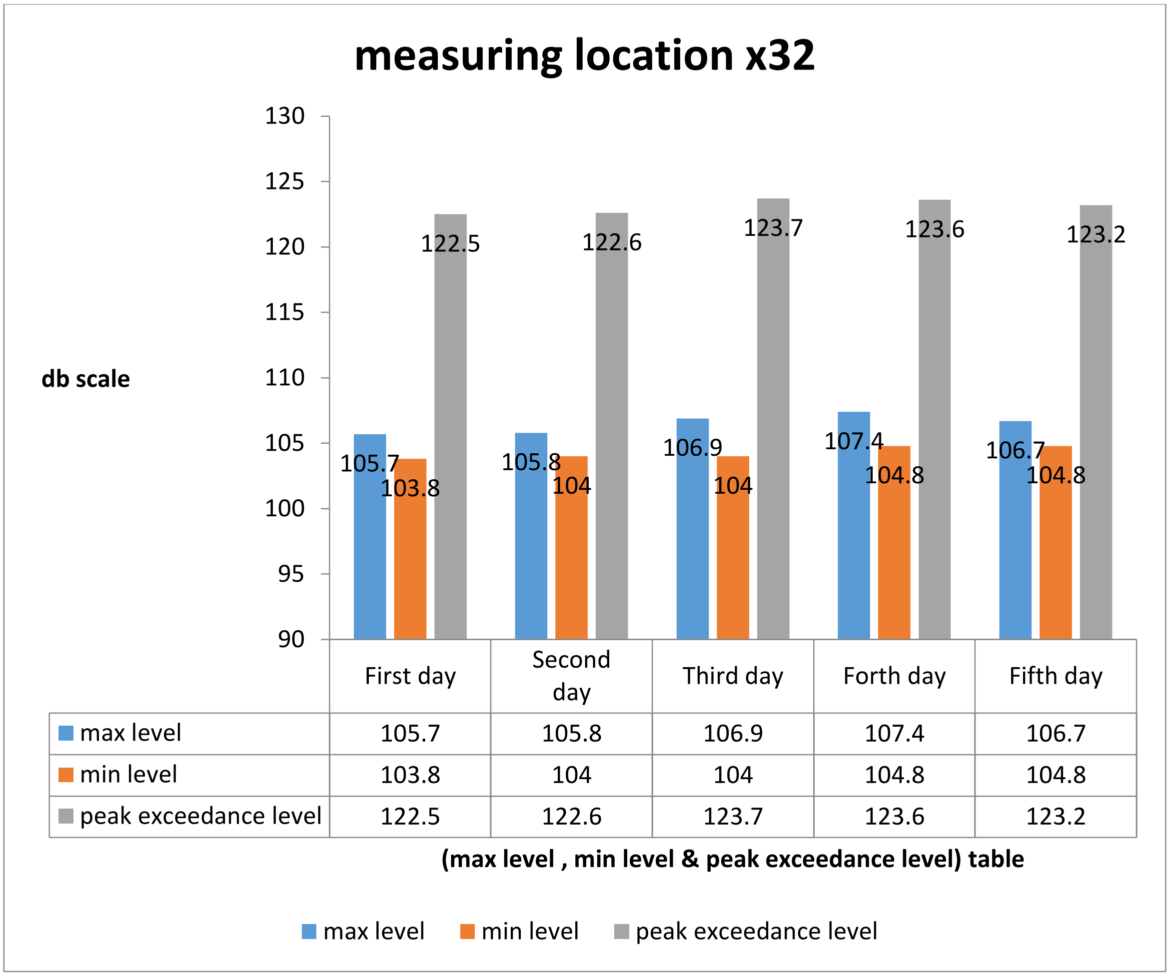
$$X'31\text{max} = \frac{96.3 + 95 + 102 + 101.1 + 98.3}{5}$$

$$X'31\text{max} = 98.54 \text{ db A}$$

$$X'31\text{min} = \frac{92.1 + 91.8 + 93.1 + 96.2 + 93.6}{5}$$

$$X'31\text{min} = 93.36 \text{ dbA}$$

4.1.6.7 X32 Location (at the door generator room, GTU14)



	First day	Second day	Third day	Forth day	Fifth day
max level	105.7	105.8	106.9	107.4	106.7
min level	103.8	104	104	104.8	104.8
peak exceedance level	122.5	122.6	123.7	123.6	123.2

Figure 4.32 Max, min and peak exceedance level at location X32, GTU14.

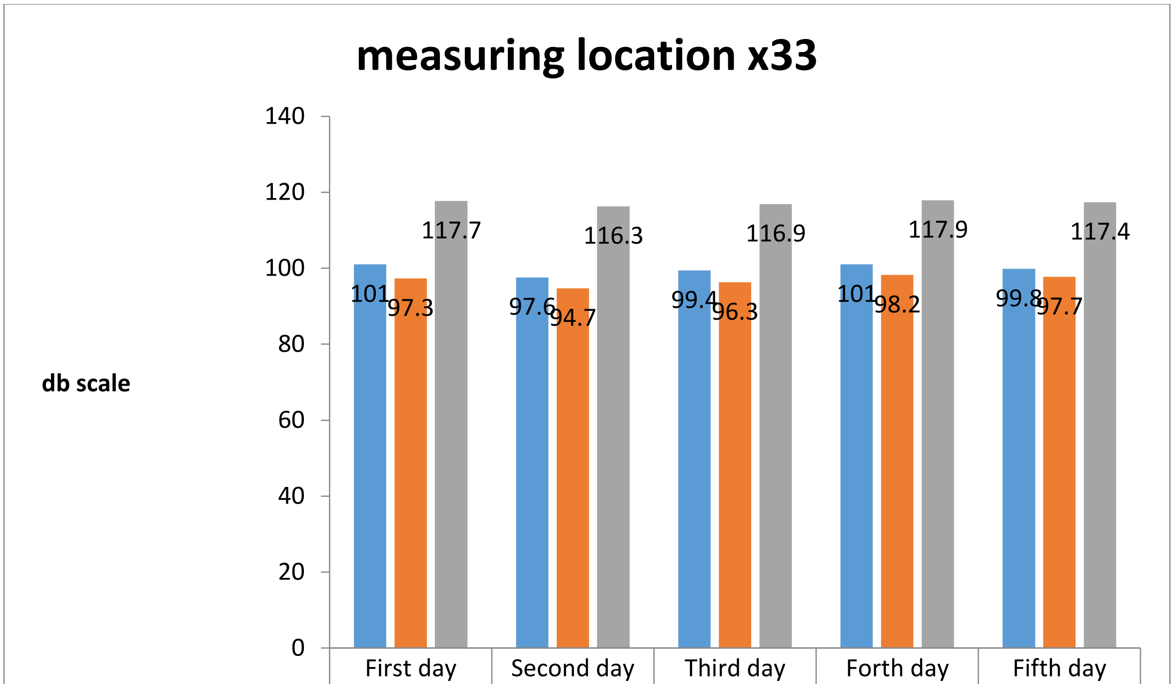
$$X^{'}32\text{max} = \frac{105.7 + 105.8 + 106.9 + 107.4 + 106.7}{5}$$

$$X^{'}32\text{max} = 106.5 \text{ db A}$$

$$X^{'}32\text{min} = \frac{103.8 + 104 + 104 + 104.8 + 104.8}{5}$$

$$X^{'}32\text{min} = 104.28 \text{ db}$$

4.1.6.8 X33 Location (at the door auxiliary boiler room (2), GTU14)



	First day	Second day	Third day	Forth day	Fifth day
max level	101	97.6	99.4	101	99.8
min level	97.3	94.7	96.3	98.2	97.7
peak exceedance level	117.7	116.3	116.9	117.9	117.4

Figure 4.33 Max, min and peak exceedance level at location X33, GTU14.

$$X'33\text{max} = \frac{101 + 97.6 + 99.4 + 101 + 99.8}{5}$$

$$X'33\text{max} = 99.76 \text{ db A}$$

$$X'33\text{min} = \frac{97.3 + 94.7 + 96.3 + 98.2 + 97.7}{5}$$

$$X'33\text{min} = 96.84 \text{ dbA}$$

4.2 RESULTS AND DISCUSSION

The average of the maximum sound level have been taken for five days reading according to employees exposed in the thirty three locations at the power station have been evaluated with respect to the OSHA standard as shown in table(3.34). table(3.34) considered result to analyses average (maximum level) sound for five days at each point are following .

Table(4.34) Average (max & min) fife days value db A

location	Average five days max value db A	location	Average five days max value db A
$X'1$	85.8	$X'18$	91.26
$X'2$	88.68	$X'19$	93.26
$X'3$	90.64	$X'20$	93.4
$X'4$	92.18	$X'21$	91.36
$X'5$	83.98	$X'22$	94.38
$X'6$	92.04	$X'23$	100.9
$X'7$	94.62	$X'24$	102.18
$X'8$	93.96	$X'25$	102.54
$X'9$	91.16	$X'26$	92.48
$X'10$	92.42	$X'27$	108.32
$X'11$	95	$X'28$	108.18
$X'12$	95.08	$X'29$	110.84
$X'13$	96.86	$X'30$	112.8
$X'14$	95.06	$X'31$	98.54
$X'15$	91.1	$X'32$	106.5
$X'16$	89.92	$X'33$	99.76
$X'17$	92.6		

Therefore this result found the following results :

First At location ($X'1, X'2, X'5, X'16$) the average level of sound lower than (90) db A which will indicate with respect to OSHA standard in allowed to work in that location not more than (8) hr. and consider this range in save side to work. Second At location ($X'3$) the average level of sound lower than (90.64) db A which will indicate with respect to OSHA standard in allowed to work in that location not more than (07:30) hr. Third At location ($X'9$, $X'15, X'18, X'21$) the average level of sound range from (91.1) db A to (91.36) db A which will indicate with respect to OSHA standard in allowed to work in that location not more than (07:00) hr. Forth At location ($X'4$, $X'6, X'10, X'17$ and $X'26$) the average level of sound range from (92.04) db A to (92.6) db A which will indicate with respect to OSHA standard in allowed to work in that location not more than (06:00) hr. Fifth At location ($X'19$ and $X'20$) the average level of sound in (93.26 and 93.4) db A which will indicate with respect to OSHA standard in allowed to work in that location not more than (05:00) hr. Sixth At location ($X'7, X'8$ and $X'22$) the average level of sound range from (93.96) db A to (94.62) db A which will indicate with respect to OSHA standard in allowed to work in that location not more than (04:30) hr. Seventh At location ($X'11, X'12$ and $X'14$) the average level of sound range from (95) db A to (95.8) db A which will indicate with respect to OSHA standard in allowed to work in that location not more than (04:00) hr. Eighth At location ($X'13$) the average level of sound in (96.86) db A which will indicate with respect to OSHA standard in allowed to work in that location not more than (03:30) hr. Ninth At location ($X'31$) the average level of sound in (98.45) db A which will indicate with respect to OSHA standard in allowed to work in that location not more than (02:30) hr. Tenth At location ($X'33$) the average level of sound in (99.76) db A which will indicate with respect to OSHA standard in allowed to work in that location not more than (02:15) hr. Eleventh At location ($X'23$) the average level of sound in (100.9) db A which will indicate with respect to OSHA standard in allowed to work in that location not more than (02:00) hr. Twelfth At location ($X'24$ and$X'25$) the average level of sound in (102.18 and 102.54) db A which will indicate with respect to OSHA standard in allowed to work in that location not more than (01:30) hr. Thrifty

At location ($X'32$) the average level of sound in (106.5) db A which will indicate with respect to OSHA standard in allowed to work in that location not more than (00:50) hr. Frothy At location ($X'27$ and$X'28$) the average level of sound in (108.18 and 108.32) db A which will indicate with respect to OSHA standard in allowed to work in that location not more than (00:35) hr. Fifthly At location ($X'29$) the average level of sound in (110.84) db A which will indicate with respect to OSHA standard in allowed to work in that location not more than (00:30) hr. Sixthly At location ($X'30$) the average level of sound in (112.8) db A which will indicate with respect to OSHA standard in allowed to work in that location not more than (00:20) hr.

Chapter 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Noise hazard is one of the major disturbing factors in human everyday life. It causes annoyance, difficulties in concentration and performing tasks, and hearing impairments. Moreover, the continuous exposure to noise leads to non-auditory health disorders. High levels of noise hazard were shown to be associated with higher blood pressure, sleep deprivation, increased levels of stress hormones. The above mentioned factors pose a higher risk of cardiovascular diseases, and a major cause of mortality in the world. That is why active noise abatement actions need to be taken in order to secure the health and well-being of the nation. The methods of noise hazard control include active and passive ones. The passive ones in turn can be separated into those that control the source of noise and that control noise at the end point of affected person. Active methods that involve a generation of opposite polarity sound to cancel noise are expensive and are used only in specialized industrial applications. Noise control actions can be enforced through the legal regulations of corresponding governmental authorities. This research consist of an important subject safety health in production system filed, where in this phenomena of worker health damage, that they have to work near high noisily machines, it focus exactly on maintenance and operation workers at Alzawih power plant, which will create many problem to the health such as noises and sleep disorder, Noise and cardiovascular diseases, Noise and cognitive performance, noise and endocrine system, maybe cause loss hearing and economic impact of noise pollution because do not able to communicate with another people in surrounding work place and outer it. By virtue of OSHA standard recommendation as sound level by db A scale with period exposed per hour has studied in chapter two table (2.3)

According to the work place designed thirty three locations were shown in fig(3.3) to fig(3.35) have been selected in the plant power station, because of their inclusion of high pressure and high temperature gauges, which need to be checked in the daily basis for long time from the work period. These locations results the measurement by dosimeter are in table(5.1) :Table (5.1) Average (max) fife days value db

Table (5.1) The average results in dbs of all the locations under study.

location	Average five days max value db A	location	Average five days max value db A
X′1	85.8	X′18	91.26
X′2	88.68	X′19	93.26
X′3	90.64	X′20	93.4
X′4	92.18	X′21	91.36
X′5	83.98	X′22	94.38
X′6	92.04	X′23	100.9
X′7	94.62	X′24	102.18
X′8	93.96	X′25	102.54
X′9	91.16	X′26	92.48
X′10	92.42	X′27	108.32
X′11	95	X′28	108.18
X′12	95.08	X′29	110.84
X′13	96.86	X′30	112.8
X′14	95.06	X′31	98.54
X′15	91.1	X′32	106.5
X′16	89.92	X′33	99.76
X′17	92.6		

The colors of the locations shown in the table (5.1)are describe the degree of the dangers noise during the working shift, and the recommended method to control it.

dbA	These locations are save for one shift to work
dbA	These locations needed to have personal hearing Protection as (wearing earmuffs and earplugs)as a management control tool.
dbA	These locations needed to have personal hearing Protection as management control in addition to some Engineering control
dbA	These locations are very danger to exposed which are not allowed for the employees health .

5.2 Recommendations:

1) Educate employees and officials about dangers of noise .
2) Awareness courses for operating and maintenance workers in occupational safety and noise hazard are needed , because of the gradually effect of the noise begins with turbulence in sleep fragmentation, lack of focus, an advanced stage of blood pressure and hearing loss may lead to death.
3) Taken tough decisions management to the workers they require developing protecting them self by using earplug to reduce noise in Al zawih power station.
4) To provide the employee's by noise measurement equipment for each Department to determine the noise level in danger places .
5) Routine screening devices and routine maintenance and periodic lubrication of machines to reduce noise sources of noise , especially in the rotating parts such as pumps and the like.

6) Employers must be taken into account the reduction of working hours in some places which have unpermitted noise according with OSHA standard
7) The knowledge are required to minimize the risk of noise pollution in the Libyan electricity companies such as the Al zawih power station.

5.3 Future work

I. Some location have been omitted, due to the regulation of the management of the power stations.
II. Extended study could be done by considering the measurement of the environmental factor such as temperature, humidity and wind speed.
III. Classification of the employee age and sex could give move solvable results

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APPENDIXES(1)

The result of measured at one point

are following:

User entered information:

Company name	the power station of alzawih
Location	x1

....

Setup information:

Setup name	ISO90
Dosimeter model number	CEL-360
Dosimeter serial number	000000
Frequency weighting for RMS	A
Frequency weighting for Peak	C
Time weighting	Fast
Measurement range	70 - 140 dB

....

User calibration information:

Microphone serial number	80031820134

Calibration times:

	dd/mm/yyyy	hh:mm:ss		
Calibrated before run on	04/06/2013	22:08:17	at	114.0 dB
Calibrated after run on	--/--/----	--:--:--	at	---.- dB

....

Logging time information:

			Duration
	dd/mm/yyyy	hh:mm:ss	dd:hh:mm:ss.ss
Start of run	05/06/2013	10:32:00	
End of run	05/06/2013	10:37:00	
Duration of run			00:00:05:00.00
Duration of pause			00:00:00:00.00

....

Measurement result information:

Equivalent sound level LAeq	86.1 dB Q = 3
Sound exposure level LAE	110.9 dB No threshold; No criterion; Q = 3
LAF10.0%	86.5 dB
LAF50.0%	86.0 dB
LAF90.0%	86.0 dB
LAF95.0%	85.5 dB
LAF99.0%	85.5 dB

Sound exposure	0.01 Pa2hr
Sound exposure	48.77 Pa2sec
Daily personal exposure level Lep,d	66.3 dB
Daily personal exposure level Lep,v	---.- dB
User specified exposure time for Lep,v	00:00 hh:mm

Threshold level	70 dB
Criterion level	90 dB
Exchange rate Q	3
Actual measured dose	0.4237 %
8 Hour projected dose	40.678 %
User specified projected period	08:00 hh:mm
User specified projected dose	40.678 %

Exceedance times (from SPL levels):

	hh:mm:ss	for % of run
Time under range	00:00:00.00	0.00 %
Above or equal to 70 dB	00:05:00.00	100.00 %
Above or equal to 85 dB	00:05:00.00	100.00 %
Above or equal to 90 dB	00:00:00.76	0.25 %

Above or equal to 100 dB	00:00:00.00	0.00 %
Above or equal to 115 dB	00:00:00.00	0.00 %
Above or equal to 140 dB	00:00:00.00	0.00 %
Time over range	00:00:00.00	0.00 %
Above or equal to user specified level		00:05:00.00 100.00 %
User specified level	80 dB	

Exceedance levels:

		at dd/mm/yyyy hh:mm:ss
RMS maximum level (Fast)	91.8 dB	at 05/06/2013 10:34:01
RMS minimum level (Fast)	85.2 dB	at 05/06/2013 10:32:59
Peak exceedance level	106.7 dB	at 05/06/2013 10:34:00

Statistical exeedance levels:

None

....
....
Time history profile information:

Profiles	On
Profile sample interval	1 min
Profile function	LAFmx
Profile function	LAFmn
Profile function	LAeq
Profile function	LCpk
Profile function	n.a.
Profile function	n.a.
Profile function	n.a.
Profile function	n.a.
Profile function	n.a.
Profile function	n.a.

C:\users\libya\desktop\data\2.dta

- Profile -

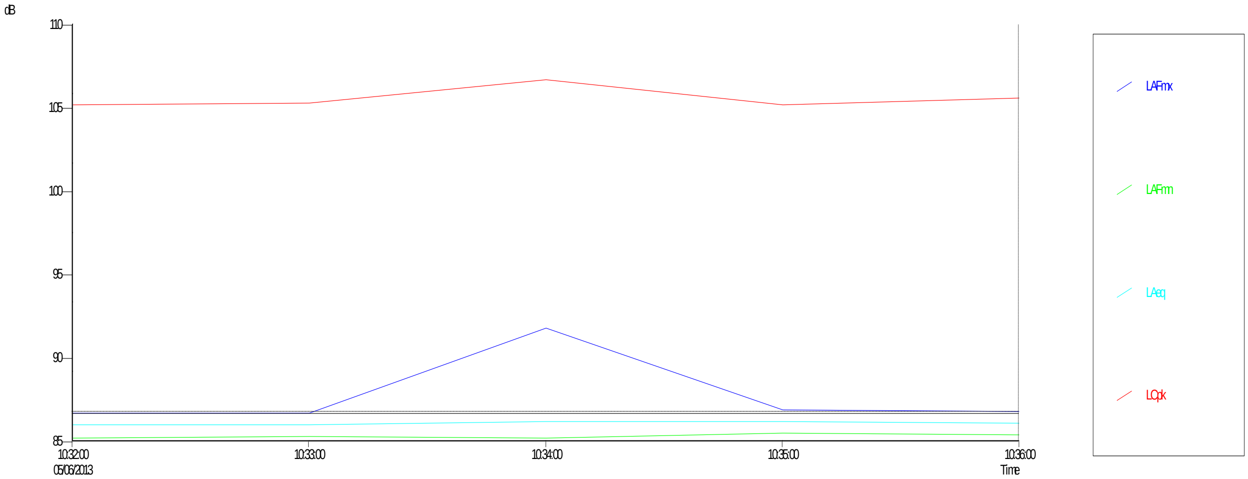
Under-load occurred	No
Overload occurred	No
Low battery occurred	No

Number of pauses None
Profile sample interval 1 min
First datapoint listed 1 : 5

Note: Meaning of Flags U,O,B,P and Z :-

- U under range
- O over range
- B battery low
- P paused
- Z zero value

Datapoint	Flags (UOBPZ)	Date and Time	LAFmx dB, (A)	LAFmn dB, (A)	LAeq dB, (A)	LCpk dB, (C)
1	-----	05/06/2013 10:32:00	86.7	85.2	86.0	105.2
2	-----	05/06/2013 10:33:00	86.7	85.3	86.0	105.3
3	-----	05/06/2013 10:34:00	91.8	85.2	86.2	106.7
4	-----	05/06/2013 10:35:00	86.9	85.5	86.2	105.2
5	-----	05/06/2013 10:36:00	86.8	85.4	86.1	105.6



C:\users\libya\desktop\data\2.dta
Overall profile duration = 00:05:00 (5 samples)
Cursor 1: Time = 05/06/2013 10:32:00, Level = 86.7, 85.2, 86.0, 105.2 dB, Flags: -----
Cursor 2: Time = 05/06/2013 10:36:00, Level = 86.8, 85.4, 86.1, 105.6 dB, Flags: -----
Duration on / between the cursors = 00:05:00, Flags: -----, Scale: 1:1, Threshold: 70 dB

- LAFmx -

Time at or above 70 dB = 00:05:00, overall
Time at or above 70 dB = 00:05:00, on / between the cursors
Time at or above 70 dB = 00:00:00, outside the cursors
Time below 70 dB = 00:00:00, overall
Time below 70 dB = 00:00:00, on / between the cursors
Time below 70 dB = 00:00:00, outside the cursors

Maximum LAFmx = 91.8 dB, Time of maximum = 05/06/2013 10:34:00, on / between the cursors
Minimum LAFmx = 86.7 dB, Time of minimum = 05/06/2013 10:32:00, on / between the cursors

- LAFmn -

Time at or above 70 dB = 00:05:00, overall
Time at or above 70 dB = 00:05:00, on / between the cursors
Time at or above 70 dB = 00:00:00, outside the cursors
Time below 70 dB = 00:00:00, overall
Time below 70 dB = 00:00:00, on / between the cursors
Time below 70 dB = 00:00:00, outside the cursors

Maximum LAFmn = 85.5 dB, Time of maximum = 05/06/2013 10:35:00, on / between the cursors
Minimum LAFmn = 85.2 dB, Time of minimum = 05/06/2013 10:32:00, on / between the cursors

- LAeq -

Time at or above 70 dB = 00:05:00, overall
Time at or above 70 dB = 00:05:00, on / between the cursors
Time at or above 70 dB = 00:00:00, outside the cursors
Time below 70 dB = 00:00:00, overall
Time below 70 dB = 00:00:00, on / between the cursors
Time below 70 dB = 00:00:00, outside the cursors

Maximum LAeq = 86.2 dB, Time of maximum = 05/06/2013 10:34:00, on / between the cursors
Minimum LAeq = 86.0 dB, Time of minimum = 05/06/2013 10:32:00, on / between the cursors

Calculated average LAeq = 86.1 dB, overall, (Threshold = 70 dB)
Calculated average LAeq = 86.1 dB, on / between the cursors, (Threshold = 70 dB)
Calculated average LAeq = n.a., outside the cursors, (Threshold = 70 dB)

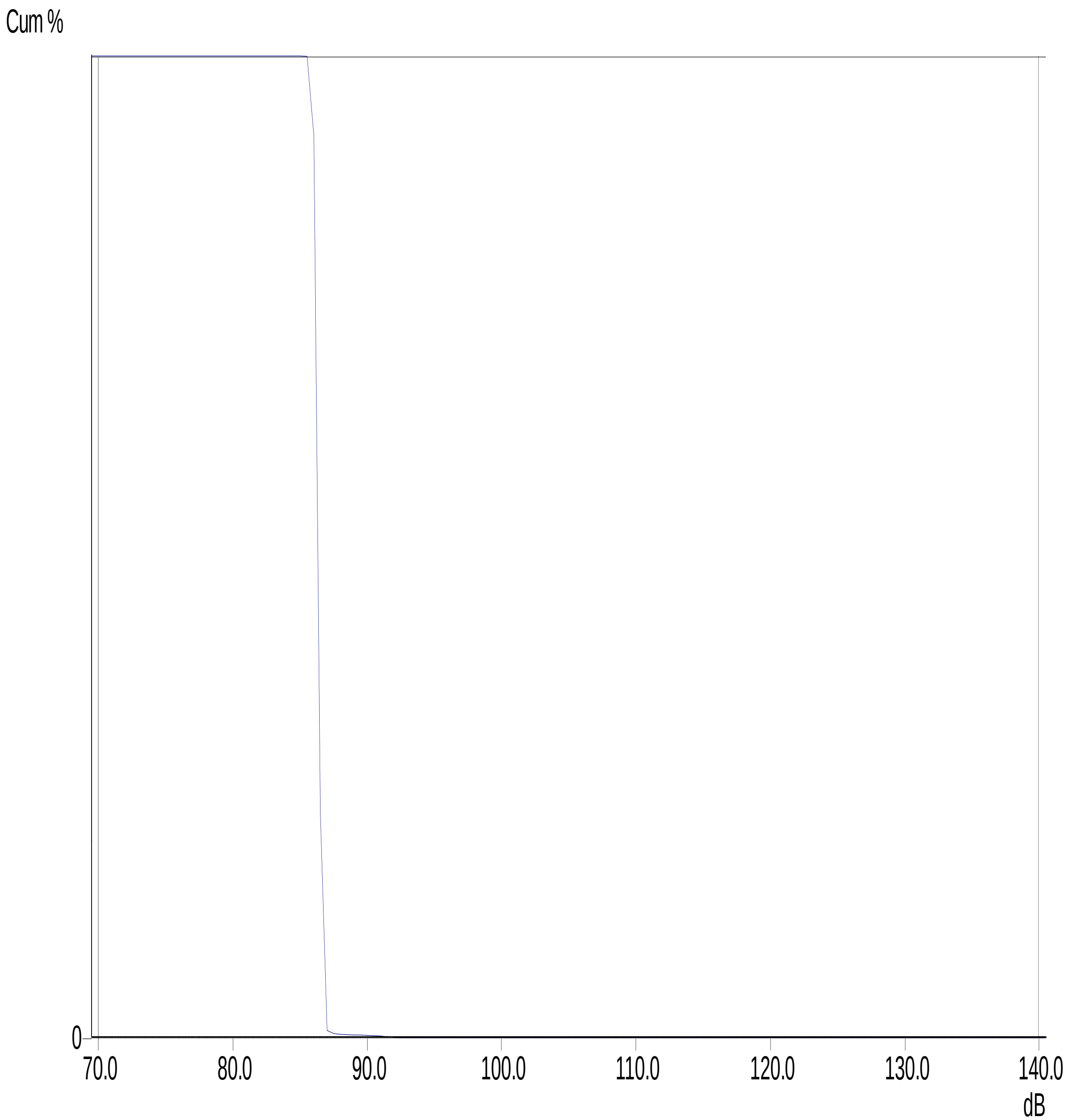
Calculated SEL = 110.9 dB, overall, (Threshold = 70 dB)
Calculated SEL = 110.9 dB, on / between the cursors, (Threshold = 70 dB)
Calculated SEL = n.a., outside the cursors, (Threshold = 70 dB)

Calculated Lep,d = 66.3 dB, overall, (Threshold = 70 dB)
Calculated Lep,d = 66.3 dB, on / between the cursors, (Threshold = 70 dB)
Calculated Lep,d = n.a., outside the cursors, (Threshold = 70 dB)

- LCpk -

Time at or above 70 dB = 00:05:00, overall
Time at or above 70 dB = 00:05:00, on / between the cursors
Time at or above 70 dB = 00:00:00, outside the cursors
Time below 70 dB = 00:00:00, overall
Time below 70 dB = 00:00:00, on / between the cursors
Time below 70 dB = 00:00:00, outside the cursors

Maximum LCpk = 106.7 dB, Time of maximum = 05/06/2013 10:34:00, on / between the cursors
Minimum LCpk = 105.2 dB, Time of minimum = 05/06/2013 10:32:00, on / between the cursors



C:\users\libya\desktop\data\2.dta
Frequency weighting for RMS = A
Flags = ----
Cursor 1: 70.0 dB, 100.00% (00:05:00)
Cursor 2: 140.0 dB, 0.00% (00:00:00)