1. INTRODUCTION

Noise is one of the main environmental problems of modern life and it is inseparable from human activities, urban and technological growth. National and international standards provide for a minimum of acoustic comfort for coexistence between man and industrial development.

That's why a study of noise emission and environmental noise at the PALAGUA - CAIPAL Field was carried out; samples of measurements were taken in specific (punctual) manner to meet the sound pressure level (SPL) with a duration of five minutes per sample/measurement for noise measurements and 15 minutes for ambient or environmental noise in each direction: (north, east, south, west and vertical).

The result of these measurements was compared with the maximum permissible noise emission and environmental noise standards stated in Resolution 627 of 2006 Ministry of Environment, Housing, and Territorial Development (MAVDT) and thus it was verified that they comply with environmental regulations in the PALAGUA - CAIPAL Field.

2. OBJECTIVES

- To evaluate the emission of noise and environmental noise encountered in the PALAGUA - CAIPAL Gas Field area, located in the municipality of Puerto Boyacá, Boyacá.

- To compare the obtained sound pressure levels at points monitored, with the permissible limits of resolution 627 of the Ministry of Environment, SECTOR C: RESTRICTED INTERMEDIATE NOISE, which allows a maximum of 75 dB in the daytime (7:01 to 21:00) and 70 dB in the night shift (21:01 to 7: 00 hours)

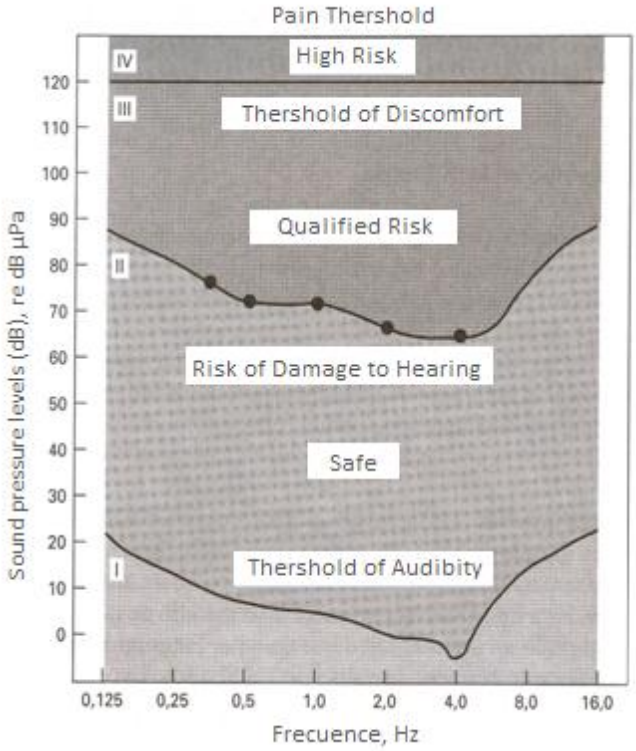
3. THEORETICAL CRITERIA

The noise is defined as sound or other unpleasant or unwanted alteration, random sound of a general nature, whose spectrum does not exhibit clearly defined frequency components (Harris, 1995).

The area of auditory sensation limits at low levels of sound pressure, with the threshold of hearing (minimum pressure level capable of evoking an auditory sensation) and at very high levels, with the threshold of discomfort, "sense of touch", pain and tickling. The average listener experiences significant distress in a free field [1] with sound pressure levels above 120 dB.

The listening area can be divided into four areas according to their potential for the happening of hearing loss. (See **Figure 1**).

Figure 1 Area of human hearing and acoustics classified by injury and potential hearing loss



SOURCE: J.H. Mills, Seminars on hearing, vol. 9, 1988, p.260.

In **Figure 1** we find that Area I is below the threshold of auditory acuity. Area II is limited by noise levels below the threshold of auditory acuity and the higher levels on the risk threshold

[1] A free field is a field of sound in which the sound wave propagates from the source without

significant effects of the boundaries or barriers.

for hearing; this region includes sounds that are audible, but pose no risk of injury or loss of hearing, whatever be the duration of exposure. The sounds within the limits of Area III represent the region of "qualified risk". Acoustic injury and permanent hearing loss due to the sounds of this area depend on the interaction of noise level, duration, number of exposures to it, time span of these exposures and the biological variables of the person being exposed.

The lower limit of Zone IV is the threshold of discomfort; the upper limit is the threshold of pain. Exposure to sounds in this area (not including impulse or impact sounds) carries a high risk of causing injury and producing hearing loss, even when the sounds are relatively short (seconds or minutes) and exposure to them relatively few (perhaps only one).

One of the categories in which you can divide the effects of noise upon hearing, is the temporary shift of the hearing threshold induced by noise, which results in elevated hearing levels (a loss of hearing sensitivity) after exposure to noise. In this type of movement, hearing loss is reversible. For exposure to noise at moderate sound pressure levels (80 to 105 dB) for less than 8 hours, the temporary threshold shift, 2 minutes after exposure, increases in a linear way in correspondence with increasing sound pressure level of noise.

There is a fundamentally important interaction between the sound pressure level and the duration of sound stimuli in producing temporary threshold shifts. This interaction highlights the importance of the concept of exposure. Neither the sound level nor the sound duration can be considered separately, but they must be considered together in order to describe the effects of noise on hearing.

Experiments on human subjects' exposure to noise levels between 80 and 95 dB during periods of time for over 8 hours, have shown that the temporary threshold shift increases with the increasing duration of exposure to a certain time limit and then it stabilizes. Although there are individual differences, this condition is achieved after 8 to 12 hours of exposure.

3.1 NOISE SOURCES

The degree of environmental pollution in major population centers due to or caused by noise has greater importance each day: therefore, the importance of trying to study in depth and learn about the sound sources and their physical characteristics, to reduce the noise levels they generate. Then we will mention some of the most important noise sources.

3.1.1. Noise Due to Public Works

These noise sources exist in the drilling, mainly due to the heavy machinery that is used which produces different types of noise. However, the most common are impulsive and continuous noises of fluctuating levels, such as that produced by a large pneumatic hammer. These noise sources can produce sounds with a power level of 120 dBm and includes drills, saws, etc.

3.1.2. Noise Due to Industrial Activities

It is the noise generated by the industry in general, where its level and sound spectrum can be very varied as it depends on the industrial process, as well as on its location and its production process. This is one of the reasons that industrial sites have been banned from the proximity of the urban housing area is to be away from these noise sources particularly taking into account that many industries are work day24 hours the day.

3.1.3. Noise Due to Atmospheric Agents

Storms are the main source of noise, including rain, hail, thunder, etc., which produce airborne and impact noise in certain areas of the country, as a result of their adverse climatic conditions, These noises are of great importance, reaching very high sound power levels. The wind also generates high noise levels.

3.1.4. Noise from Electric Motors

Electric motors are devices that convert electrical energy into mechanical energy. This transformation occurs in the space of air between the stator (the stationary part) and rotor (the swivel). Rotor is attached to a shaft through which mechanical energy is generated. When it receives the energy, the engine may undergo several internal electricity losses that cause an increase in temperature, which should be eliminated to ensure a balanced heating of the various components. A blower (fan) attached to the rotor is responsible for performing this task. This blower (fan) can be installed inside the engine in order to boost air into and winding through or toward the outer surfaces of the engine cover.

The main sources of noise can be classified according to their origin, which may be mechanical, aerodynamic or magnetic. The spectrum of this type of noise normally has significant components of simple frequency overlapping broadband noise. These simple frequency components in the noise spectrum may be caused by intermittent movements of

various parts due to the action of cyclic forces, intermittent interruptions of air flow cooling, or stimuli on the natural frequencies of engine components due magnetic forces.

Table 1 lists the higest limits of sound power levels for induction motors of different sizes and speeds that meet the design requirements set by the National Electrical Manufacturers Association (NEMA).

Table 1 Higest limits of A-podered STL for NEMA Standard Sizes

FRAME SIZE	SYNCHRONIZED SPEED, rpm	SPL with A, db re pw	
		AIR COOLING	ENGINES WITH OPEN DRIP PROTECTION
140	1200	64	65
280	1200	80	81
440	1200	96	91
140	1800	70	70
280	1800	88	80
440	1800	102	93
140	3600	87	76
280	3600	98	86
440	3600	104	101

3.1.5. Noise from Generators

The main noise emitted by a generator is due to magnetic forces that occur in the air space. Generator rotors have two or more magnetic poles. The attraction that is produced by these magnetic forces can cause deformation of the lamination or the frame of the stator. This deformation whirls towards the prominences of the magnetic poles, causing vibrations. The aerodynamic noise source is usually less important in small generators, but may be less significant in larger ones.

3.1.6. Noise from Transformers

Transformers are an essential element of the transmission and distribution of electric energy in electric webs or grids. A transformer used to convert high voltage and low current electricity to low voltage and high current electricity, or vice versa (AC to DC).

The main sources of noise in transformers are: the nucleic noise, due to the magnoestriction properties of the steel nucleus (buzzing sound); and the ring sound, produced primarily by electromagnetic forces associated with alternate current flow circulating through the induction coil, and the fan noise caused by the cooling system of the transformer.

3.1.7. Noise from Gears

A gear is a toothed wheel whose teeth are arranged so that when they fit the sprocket of another toothed wheel, the former's teeth or another fixed object; a motion is passed. In general, this movement occurs when two gears mounted on axes, whose teeth are designed to maintain a constant angular velocity rate of a centimeter to several meters in diameter, mesh.

The deformations in the teeth and the deviations from perfectly equidistant surfaces that involute occur on surfaces of non-load rolling averages are combined to produce the deviation of the average load rolling surface, being the main cause of harmonic sounds in between toothed gears.

3.1.8. Noise from Bearings

A bearing is a piece that allows the realization of linear or rotary movements between two components of a machine by transferring the load from one component to the other at the same time.

The noise produced by bearings is usually due to imperfections in the rolling surfaces that prevent proper displacement and cause instability. The surface condition of the bearing depends on its initial quality and to Drilling, of the design of the machine in which it is inserted, and the resulting operating conditions of this machine.

3.2. EVALUATION INDEXES FROM DIFFERENT NOISE SOURCES

3.2.1. Sound Pressure Level throughout the Entire Track

Not pondered level of the audible frequency range.

3.2.2. Pondered Sound Pressure Level

 Pondered A: scale measuring levels established by the use of the weighting curve A (UNE Standard 21.314/75) to compensate for differences in sensitivity of the human ear to different frequencies within the hearing range (follows approximately the isophone curve of 40 dB.
 Pondered B: follows the isophone curve of approximately 70 dB.

- *Pondered C*: follows the isophone curve of approximately 100 dB.
- *Pondered D*: roughly follows the outline of sound (noise from aircraft).
- *Pondered E*: Conducts the perceived sound level estimation.

3.2.3. Equivalent Continuous Sound Level

It is the level in dB (A) of a hypothetical constant noise, corresponding to the same amount of energy that the actual noise considered, at some point during a time period T.

3.2.4. Sound Level LN

This index is calculated by statistical analysis of noise, where the level of noise in dB (A), which has exceeded during N% of the time of measurement.

- **L10:** is the sound pressure level in dB (A) that has exceeded during 10% of the observation time (used to indicate peak levels).

- **L50:** is the sound pressure level in dB (A) that has exceeded during 50% of the observation time.

- **L90:** is the sound pressure level in dB (A) that has exceeded during 90% of observation time (used to indicate the ambient /environmental level).

3.3. Calculation of Noise Exposure Due to Noise Level and Duration

The sound level-pondered equivalent continuous (symbol Leq or LAeq, T), in decibels, at a place during a time interval *T* in hours, is related to the total sound exposure *E* in square Pascals per hour, which occurs within this period represented by the formula:

$$E = (p_o^2 T)\,[10^{0.1 \times Leq}]$$

The sound exposure level is a useful index to calculate the noise levels resulting from any combination of sound sources. The sound exposure level measured in decibels, gives the relation between the noise exposures measured in square Pascals per time unit and standardized referencesound exposure of 20 squared micro-pascals per time unit. When environmental noise is the result of the sounds forthcoming from one or more identifiable acoustic events, the corresponding equivalent continuous sound level over a specified time interval can be calculated easily from sound exposure levels of the events (or groups of events within the set). The individual noise exposure in each of the N periods of time (E1, E2, ..., IN) can be calculated by applying the equation described above and with the subsequent addition over the N periods we obtain that the total sound exposure **ES**, according with:

$$E_s = E_1 + E_2 + \ldots + E_n$$

3.4. ANNOYANCE INDUCED BY NOISE

Discomfort is often described as a generalized attitude adverse to noise exposure or, if defined in terms of behavior, it is said that a noise is annoying if the person tries to avoid it. Furthermore, discomfort is influenced by a variety of acoustic and non acoustic factors. Acoustic factors include the absolute level, their duration, and the spectral distribution of sound energy as well as its fluctuations. Non-acoustic factors include adaptation (habituation or sensitization), degree of involvement in activities that are performed at the time of the exposure to noise, attitudes toward the sources of the noise and its operators (approval, fear, distrust, etc.), socio-economic levels of people, economic dependence upon the performance of the noise sources, and the apparent need and predictability of the noisy intrusions.

A social survey properly conducted can provide detailed information not only about the discomfort, but also about the interference in activities due to noise. The information that can be obtained includes:

1. The percentage of the community that is experiencing speech interference.
2. Sleep interference and inconvenience attributable to certain noise sources.
3. The importance of such effects in different parts of the community.
4. The time of day when the effects occur.
5. The degree to which exposure to noise affects different segments of the community.
6. The prevalence of favorable and unfavorable attitudes toward the sources of noise.
7. Perspective on the relative magnitude of the effects of different primary sources of noise.
8. Economic dependence of the community on the noise sources.

3.4.1. Relation between Annoyance and Sound Level Corrected Day – Night

The problem in the long-term community exposure to noise can be expressed as a function of sound level corrected day - noche2 (Ldn); the functional relationship is described by the following quadratic equation:

$$\% \text{ very disturbing} = 0{,}036\ L_{dn}^{2} - 3{,}27\ L_{dn} + 79{,}14$$

This relationship assumes that the trouble is caused solely by acoustic variables.

3.5 POSSIBLE HEALTH IMPLICATIONS CAUSED BY EXPOSURE TO NOISE

Results from several studies support the hypothesis that the noise has to be considered a risk factor for health, leading to the appearance of certain disorders such as hypertension, heart disease and biochemical changes. In a model of multiple risk factors you have to distinguish between primary and secondary risk factors. The primary factors are somatic (describable physiologically). The secondary factors, including the processes of the human social environment, influence and even cause the primary factors through emotional processes reflected by the nervous system.

Specific research show the physiological effects of noise on muscle activity (e. g. muscle tension, shock), respiratory reflexes (after short pulses - 2 seconds - of tones with a frequency of 1000 Hz, at sound pressure levels of 70, 90 and 120 dB, breathing movements become greater and slower), heart and circulation (e.g. changes in heart rate, vasoconstriction in the skin), eye pupil (a broadband noise with a sound pressure level 75 dB approx., is the lowest level seen to cause the pupil dilation), balance (altered by the broadband noise sound pressure levels above 100 dB). Sometimes stress is considered as the cause of the physiological effects of noise. The trend towards achieving stability, within limits of different physiological parameters, versus all influences including the internal and the external environment, aim to produce changes in what is called homeostasis, and are related to the degree of stress generated from the noise.

[2] Sound Level for 24 hours with the correction of 10 dB to sound levels of the nighttime hours.

4. METHODOLOGY

At the Location point sites described in this report noise measurements were taken with a sound level meter, QUEST ELECTRONIC INC. Brand, model 2900, previously calibrated with scaled pondering filter A. The sound level meter features are presented in **Table 2.**

Table 2 Characteristics SLM (Sound Level Meter)

SLM QUEST ELECTRONIC MOD. 2900	
STANDARDS THAT ARE MET	ANSI S 1.4-1983 TYPE 2 IEC 651-1979 TYPE 2 IEC 804-1985 TYPE 2 RMS, 63 dB
DETECTOR:	20 – 140 dB
RANGE:	A, C, LINEAL
FREQUENCY:	120 dB
UPPER LIMIT:	80 – 90 dB
THRESHOLD:	4 DIGIT LIQUID CRYSTAL
READING:	0.01 – 19999
DOSE:	½ " WITH CONDENSATION
MICROPHONE:	Prepolarized
TEMPERATURE:	-10 A +50°C
HUMIDITY :	0 – 95%
MAGNETIC FIELD EFFECT:	NOT SIGNIFICANT

SOURCE: ANTEK S.A. (November, 2009)

4.1 PRE-POLARIZED CONDENSER MICROPHONE

Pre-polarized microphones operate according to the same principle as condenser microphones of conventional design, which relies on changes in electrical capacity to develop corresponding changes in voltage. However, the electric field is not set or determined by an external voltage polarization bias, but it is set by charges that are trapped by "permanently" on or attached to a special polymer material, so that the positive charge preponderance resides on one side of the material and the negative charges on the other.

Due to the fact that pre-polarized microphones may easily have the same characteristics as conventional electro- microphones that condenser microphones are suitable

for measuring sound levels meeting the accuracy requirements of Class (0) lab or Class (1) Accuracy.

The main advantage of these microphones is their ability to operate in wet environments: since there are no free electric charges, there is a much greater freedom for the discharge voltage in the hole between the back plate and diaphragm.

4.2 PONDERED FREQUENCY

The pondered frequency in a sound-level alters the characteristics of the frequency response according to the specifications of a national or international standard. Thus, the indication of an instrument to measure the sound level for a given level of pressure input noise depends on the frequency of the sound reaching the microphone and the weighting selected frequency.

Pondered A: The national and international standards require that all devices that measure the sound level, frequency weighting incorporate designated by the letter A. Many years of study and practical experience have shown that A-weighted sound levels provide adequate correlation with several human responses (from people or groups in a community) for different types of noise sources and consequently, is the most commonly used frequency weighting. Feature is that the weighting takes into account the reduced sensitivity of normal human hearing for low frequencies compared to the response at high frequencies.

4.3 MODEL SOUND PRESSURE LEVELS (SPL)

The modeling of sound pressure levels is a widely used tool to project the impact and / or changes in the acoustic environment, urban development and industrial processes. In the same way it can be used as a planning tool for certain environments where noise control is necessary.
Currently the market has multiple computer programs that are being used for programming external noise such as:

Soundplan 5.0.

Was used for modeling simulation software for noise control and environmental protection SOUNDPLAN 5.0, is a program that enables to optimize control measures and visualize the effect of noise propagation in industrial processes. This program is known worldwide for over a decade, being the most reliable tool, accurate and rapid progress of science in Engineering Acoustics and Noise Control, counting among its utility over 2000

universities worldwide in over 30 countries, SOUNDPLAN 5.0 is a software application that delivers clear graphic for practical applications.

To feed the software shows the precise locations of the measurements and the values reported by the meter, preferably forming a network dayof imaginary values where more information is the most representative results presented in isophonic curves and equivalent to the dispersion of noise in magnitude and direction.

4.4 STANDARDIZATION

The values of measured sound pressure levels at the OIL WELL SUCUMBIOS 4, was compared with the environmental standards established by Resolution 627 of 2006 of the Ministry of Environment, SECTOR C: NOISE RESTRICTED INTERMEDIATE for the permitted uses in industrial areas; such as industries in general, which allows a maximum of 75 dB in the daytime (7:01 to 21:00) and 70 dB in the night shift (21:01 to 7: 00 hours). This Resolution regulates the noise component in the national and it establishes the "rules concerning the protection and preservation of hearing health and welfare of people, because of the production and emission of noise." As set out in Article 14 of the reference standard, results in environmental noise measurements should be used to diagnose the noise environment. The results will lead to noise maps which allow visualization of the reality in regard to environmental noise, identify critical areas and possible noise emission pollutants.

To prevent and control nuisances, disturbances and occasional hearing loss in the population by the emission of noise, have established maximum permissible noise levels listed in Table 2 of Article 17 of this Resolution. **(**See **Table 3** Maximum Permissible Standard of Ambient Noise Levels dB (a).

Table 3 Maximum Permissible Standard of Ambient Noise Levels dB (a).

SECTOR	SUBSECTOR	Resolution 627 de 2006. Maximum Standard permissible ambient noise levels dB (a).	
		Day	Night
SECTOR A. PEACE AND SILENCE	Hospitals, libraries, kindergartens, clinics and nursing homes.	55	45
SECTOR B. PEACE AND MODERATE NOISE	Exclusively for residential areas for housing development, hotels and guesthouses.	55	45
	Universities, colleges, schools, study and research centers	65	50
	Parks in urban areas different from parks with outdoor mechanical attractions		
SECTOR C RESTRICTED INTERMEDIATE NOISE	Uses permitted in industrial areas such as industries in general, port areas, industrial parks, import/export zones.	75	70
	Areas with permitted commercial uses such as shopping centers, warehouses, commercial premises or shops, auto repair shops and industrial, recreational and leisure centers, gyms, restaurants, bars, taverns, nightclubs, bingo halls, casinos.	70	55
	Areas with office use allowed.	65	50
	Areas for institutional uses.	65	50
	Areas with other related uses, such as mechanical outdoor parks, areas for outdoor public events, crossroads, highways, arteries, main roads.	80	70
SECTOR D FIELD SUBURBAN OR RURAL QUIET AND MODERATE NOISE	Suburban Residential	55	45
	Rural housing for agriculture development		
	Recreation and rest areas, like natural parks and nature reserves		

SOURCE: MAVDT. Resolution 627 / 06

In accordance with the provisions of Resolution 627/06 Ministry of Environment, the final outcome of the measurements is given by the following equation:

$$L_{Aeq} = 10*Log\ ((1/5)*10^{LN/10} + 10^{L0/10} + 10^{L6/10} + 10^{LE/10} + 10^{LV/10}))$$

Where:

LAeq = EQUIVALENT LEVEL MEASUREMENT RESULT
LN = AVERAGE EQUIVALENT LEVEL WITH THE MICROPHONE PLACED IN NORTH BOUND POSITION
LO = AVERAGE EQUIVALENT LEVEL WITH THE MICROPHONE WESTBOUND ORIENTED
LS = AVERAGE EQUIVALENT LEVEL IN WITH THE MICROPHONE IN SOUTH BOUND POSITION
LE = AVERAGE EQUIVALENT LEVEL WITH THE MICROPHONE POSITION ORIENTED TO THE EAST
LV = AVERAGE EQUIVALENT LEVEL WITH THE MICROPHONE VERTICALLY ORIENTED

5. TYPE AND CHARACTERIZATION OF MONITORING

Readings were conducted sound pressure level (SPL) during daytime and night, through measurements of 6 minutes in each direction: North, East, South, West and Vertical, for each of the six monitoring stations, thus which attempts to establish conditions of noise emission in Production Area - AP PALAGUA - CAIPAL FIELD. Importantly, this monitoring is primarily to establish the sound pressure level (SPL) in terms of environmental noise in each of the stations in the area.

Table 4 shows the description and location of monitoring points over the randomly selected within the area of exploratory drilling and taking into account as a criterion to sensitive areas to drilling and/or exploitation of energy resources.

Table 4. Location Points Monitored for Sound Pressure Levels. PA Chichimene.

Monitored Location Point	Geographic Coordinates	Map Coordinates
Location 1. Caipal 10	N 06º07'19,6"	N 1168446,54
	E 74º30'00,4"	E 953597,61
Location 2. Workover La Pia	N 06º05'56,0"	N 1165879,97
	E 74º31'05,8"	E 951584,54
Location 3. Battery 2	N 06º05'06,7"	N 1164365,19
	E 74º30'54,2"	E 951940,03
Location 4. Industrial Area	N 06º05'01,5"	N 1164204,87
	E 74º30'30,6"	E 952665,63
Location 5. School	N 06º04'54,5"	N 1163989,82
	E 74º30'30,2"	E 952677,76
Location 6. Battery 1	N 06º04'45,9"	N 1163725,42
	E 74º30'21,2"	E 952954,31

SOURCE: ANTEK S.A. (November, 2009)

Figure 2 shows some of the monitored location points in the area.

SOURCE: ANTEK SA (November, 2009)

6. RESULTS' ANALYSIS

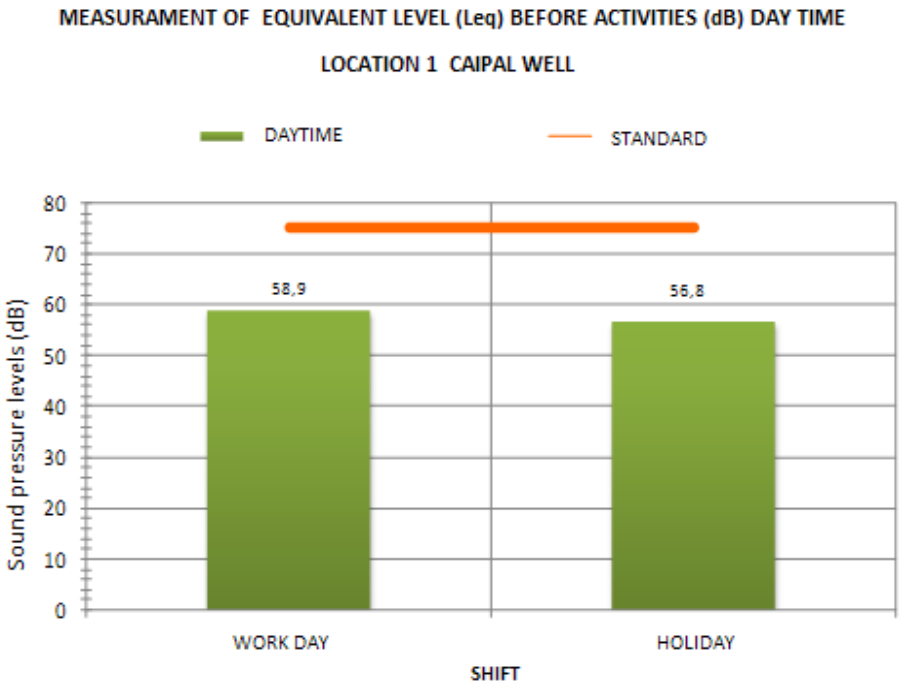
This report is complemented by **Attachment 1**, where the result tables of the measurements of the sound pressure levels (NPS) are presented; likewise, in **Attachment 2** the photograph record of each one of the points in assessment is presented; in **Attachment 3** the Day – Night isophone curves of the Production Area – AP PALAGUA - CAIPAL Field are annexed; and in **Attachment 4** the certificates of calibration of the sound meter that is used are presented.

6.1 Day Monitoring

6.1.1 Location Point 1 Oil Well Caipal 10

In **Graph 1** the measurements of the daytime Equivalent Level are presented, reported during the monitoring performed at Point 1 of analysis, for a Work day and another Holiday located at AP – PALAGUA - CAIPAL Field in study.

Graph 1



SOURCE: ANTEK S.A (November, 2009)

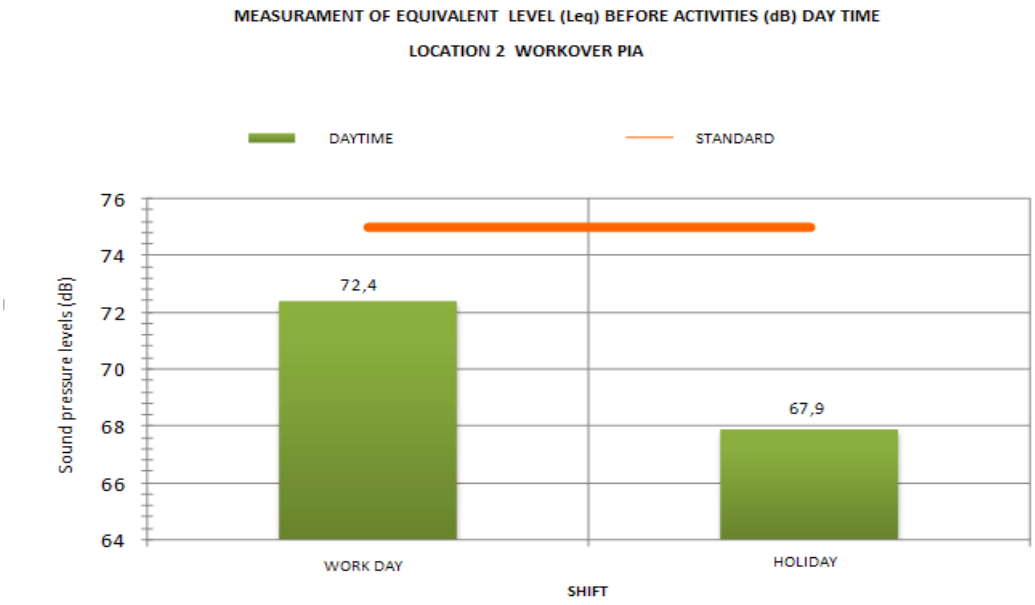
As previously evidenced, the measurement of Point 1 in daytime hours in a Work day (normal work day day) as in the Holiday complies with the limit established in the effective regulations at national level.

The maximum value was reported in the Work day, with 58,9 (dB); however, the difference between this and the measurement of the Holiday is not too big; this may be due to the fact that the equipment and machinery operate 24 hours a day, either work day or holiday.

6.1.2 Location Point 2 Workover La Pia

In **Graph 2** the daytime measurements of the Equivalent Level are presented, reported during the monitoring performed at Location Point 2 of the analysis, for a work day and another for a holiday located at PA – PALAGUA - CAIPAL Field under study.

Graph 2



SOURCE: ANTEK S.A (November, 2009)

As previously evidenced, the measurement at location point 2 during the daytime hours of a work day as, well as that of a holiday; comply with the limit established in the outstanding regulations at a national level.

The maximum value was reported during the work day, with 72.4 (dB); this is a high value. However, according to **Illustration 1**, Area of Human Audition, this measurement is

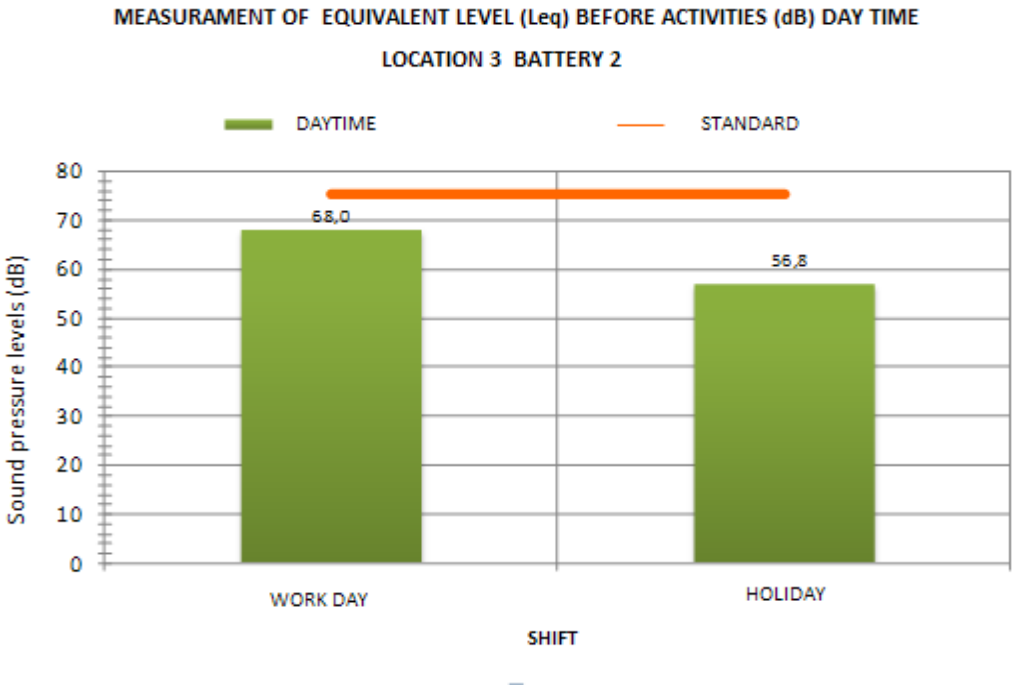
within the region that comprises audible sounds, but that do not suppose a risk of an injury, serious lesion, or permanent hearing loss.

At this point a significant difference between the measurements obtained during the work day and those corresponding to the Holiday is evidenced; that is, the activities of a work day have a big influence in the sound pressure level at this point.

6.1.3 Location Point 3 Battery 2

Graph 3 shows the measurements of the daytime equivalent level, reported during the monitoring performed at location point 3 of the analysis, for a work day and another measurement for a holiday situated at PA – PALAGUA - CAIPAL Field at study.

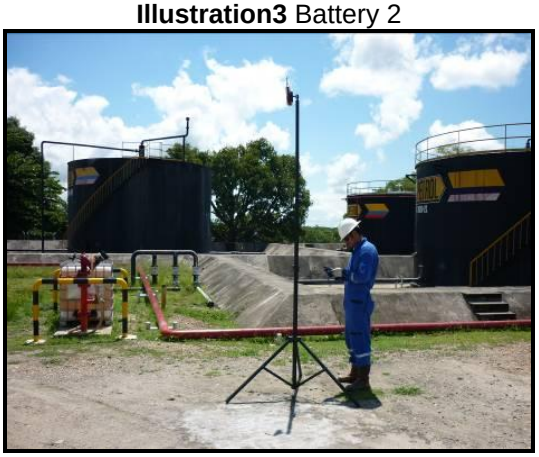
Graph 3



SOURCE: ANTEK S.A (November, 2009)

As was observed with the previous location points, the measurement at location point 3 during the daytime hours for a work day as well as for a holiday complies with the limit established in the outstanding regulations at national level. As in points 1 and 2, at this location point the maximum value was reported during the work day, with 68.0 dB, which is considerably different from the measurement obtained during the holiday. This also indicates that at this location point the influence of the work day activities is very notorious.

Illustration3 Battery 2

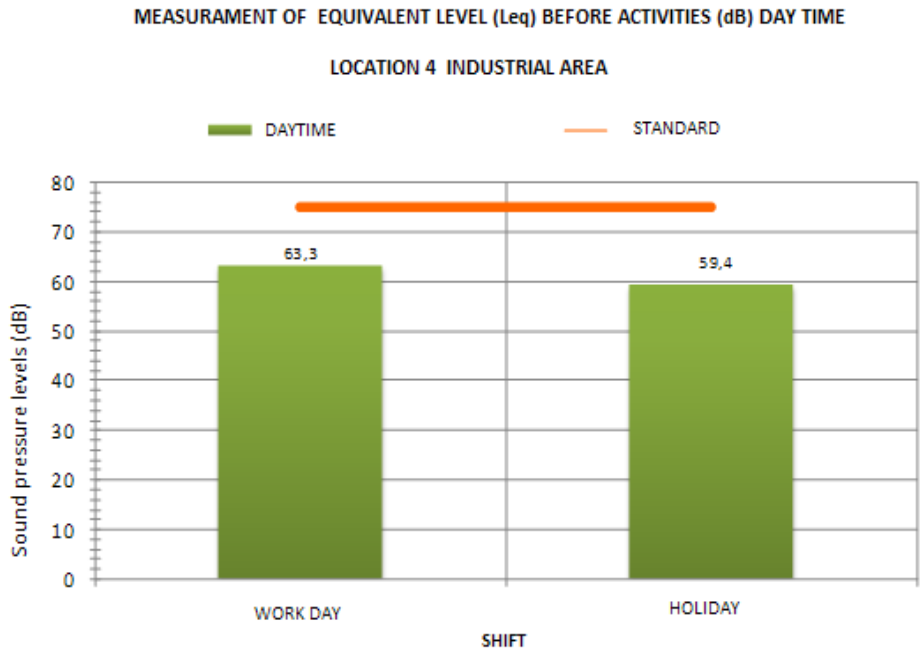


SOURCE: ANTEK S.A (Noviember, 2009)

6.1.4 Location Point 4 Industrial Area

Graph 4 presents the measurements of the daytime Sound Equivalent Level, reported during the monitoring performed at Location Point 4 of analysis, for a Work day and another Holiday located at PA – PALAGUA - CAIPAL Field under study.

Graph 4



SOURCE: ANTEK S.A (Noviember, 2009)

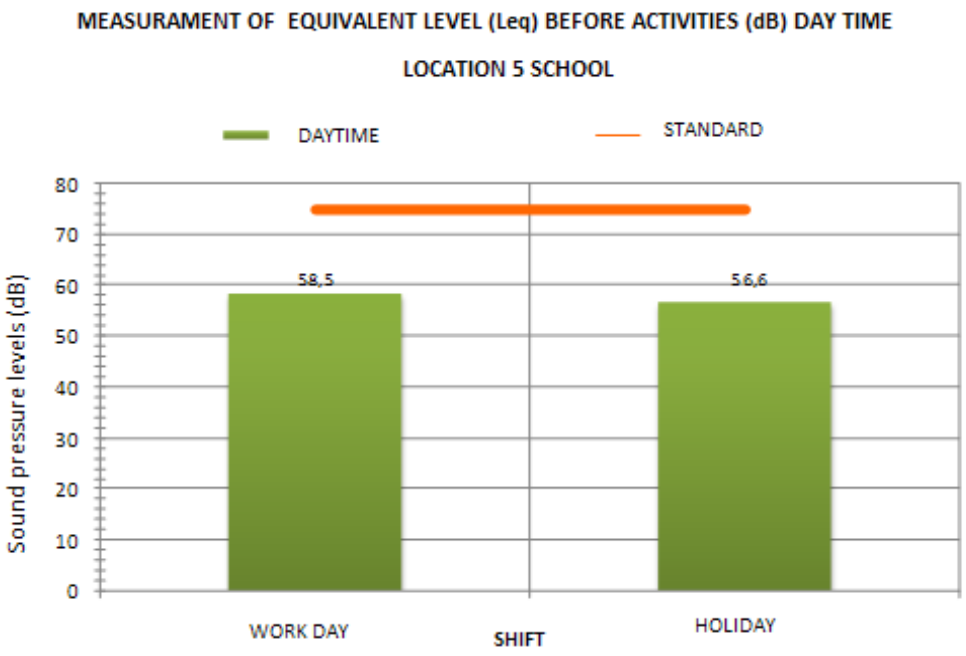
As it can be seen in the graph, the measurement of Point 4 in daytime hours in both a Work day and a Holiday complies with the limit established in the outstanding regulations at national level.

The maximum value was reported in the work day wich was 63.3 (dB); this value is not significantly different than the measurement obtained from the holiday. This may be due to the fact that the work day activities do not influence very much the sound pressure levels in this point.

6.1.5 Location Point 5 School

Graph 5 shows the sound measurements of the daytime Equivalent Level, reported during the monitoring performed at Point 5 of analysis, for a work day and another measurement for a holiday located at PA – PALAGUA - CAIPAL Field under study.

Graph 5



SOURCE: ANTEK S.A (November, 2009)

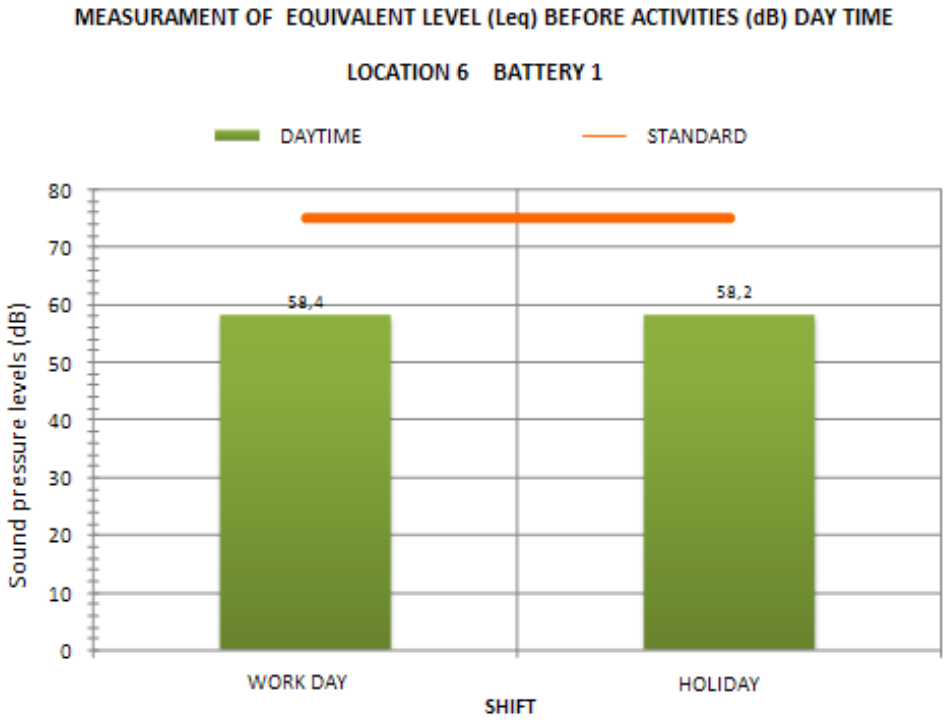
According to the graph, the sound measurement of point 5 during daytime hours, both for a work day and a holiday complies with the limit established in the outstanding regulations at a national level.

The maximum value was reported during en the Work day, with 58.5 (dB); however, the difference between this and the measurement of the Holiday is very little. This may be due to the fact that either if it is the Work day or the holiday day the equipment and machinery operate 24 hours a day.

6.1.6 Location Point 6 Battery 1

Graph 6 shows the sound measurements of the daytime equivalent level, reported during the performed at location point 6 of analysis, for a work day and another for a holiday located at PA – PALAGUA - CAIPAL Field under study.

Graph 6



SOURCE: ANTEK S.A (November, 2009)

As shown in the graph, the measurement of location point 6 during daytime hours in both a work day and a holiday complies with the limit established in the effective regulations at national level.

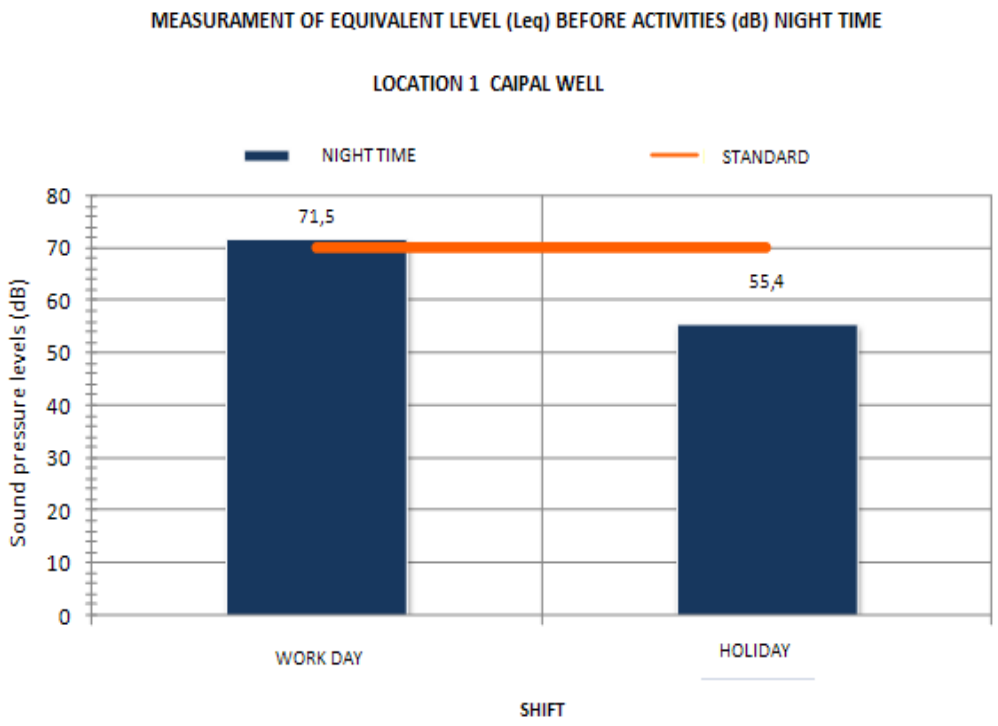
The maximum value was reported in the work day, with 58.4 dB; however, the difference that exists between this and the Holiday measurement is too small, 58.2 dB; this may be due to the fact that work day activities do not influence significantly the sound pressure levels of this point; besides, the equipment and machinery operate 24 hours a day either if it is a Work day or a holiday.

6.2 Nighttime Monitoring

6.2.1 Location 1 Oil Well Caipal 10

In **Graph 7** the measurements of the nighttime equivalent level are presented, reported during the monitoring performed at location point 1 of analysis, for a work day and another measurement for a holiday located at AP – PALAGUA - CAIPAL Field of this study.

Graph 7



SOURCE: ANTEK S.A (November, 2009)

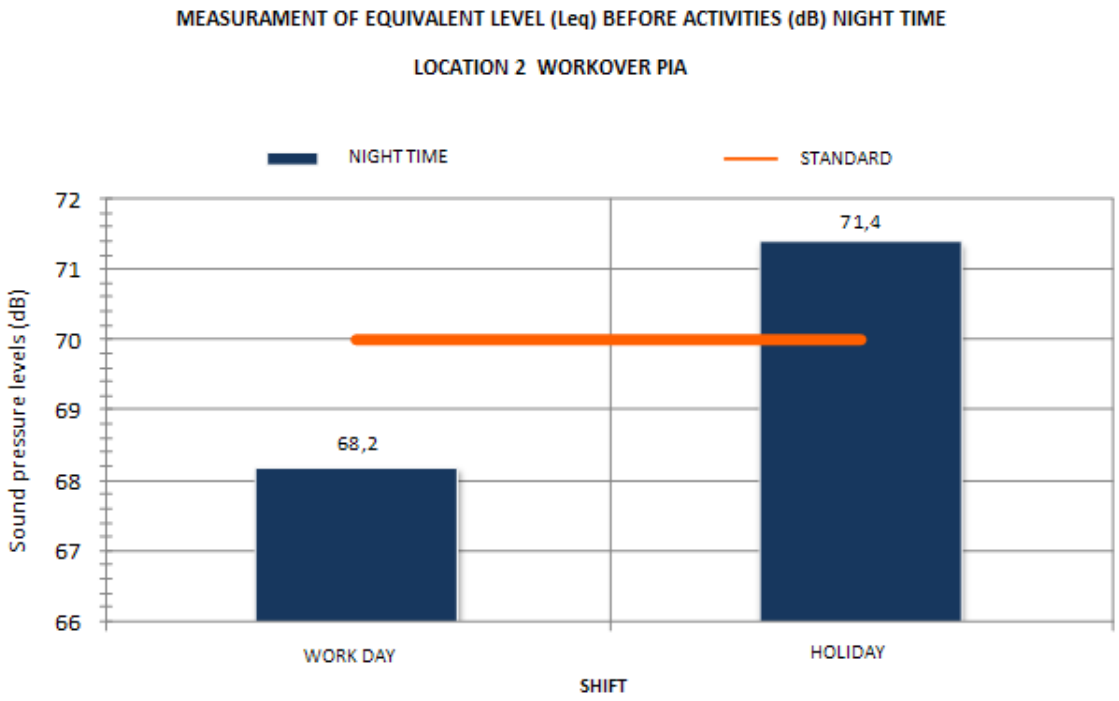
As it is evidenced above, the measurement of the work day registers a maximum value of 71.5 (dB), which exceeds the maximum limit allowed by the outstanding regulations; however, this can be explained since the machinery functions 24 hours a day. Besides,it was also observed that there are high populations of several animals present , among which are the frogs; the sound emitted by these animals influenced the increase of the sound pressure level at this point.

The holiday measurement presented a lower value with 55.4 (dB), complying with the norms, and allowing to determine that work day activities greatly influence the sound pressure levels at this point.

6.2.2 Location 2 Workover La Pia

Graph 8 shows the measurements of the nighttime equivalent level, reported during the monitoring performed at location point 2 of the analysis, for a work day and another measurement for a holiday located at the AP – PALAGUA - CAIPAL Field in this study.

Graph 8



SOURCE: ANTEK S.A (November, 2009)

As it can be seen in the graph, the measurement of the holiday is the one that registers the greater value with 71.4 (dB); on the contrary, the measurement for the work day is lower and it complies with the regulations. However, this is not very common, but it can be explained since the workover team of Pia well was not operating at the moment of the monitoring for the Work day, while in the Holiday it was. This explains the difference between the two obtained measurements.

Illustration 4 shows the location of point 2 Workover Pia.

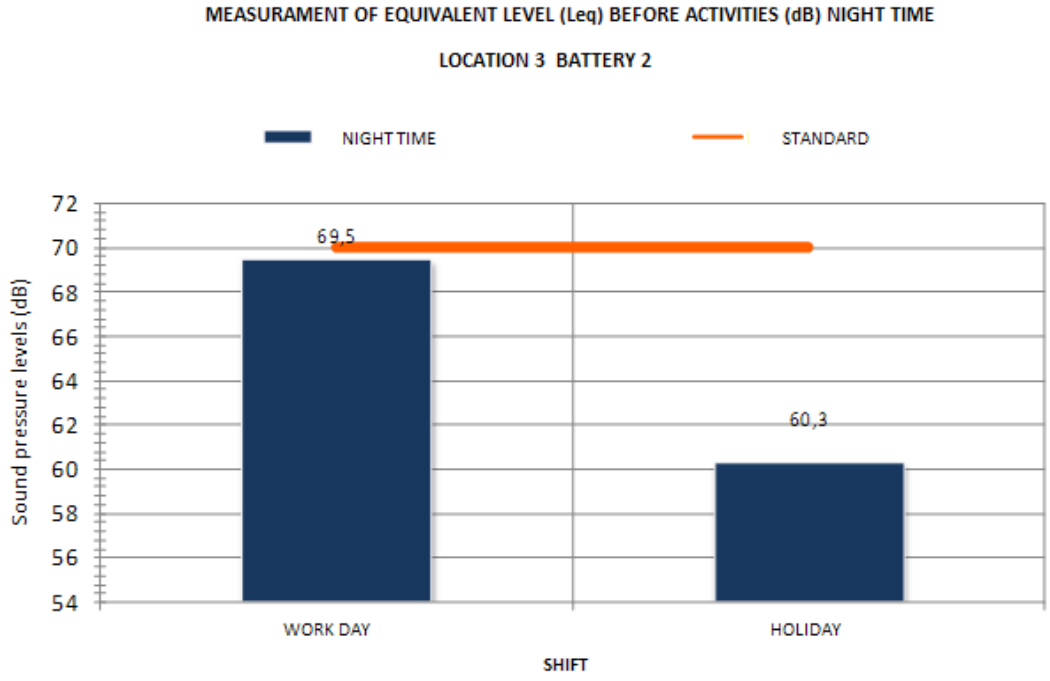
Illustration 4

Source: ANTEK S.A. (November, 2009)

6.2.3 Location 3 Battery 2

Graph 9 shows the measurements of the nighttime Equivalent Level, reported during the monitoring performed at location point 3 of analysis, for a work day and another holiday located at AP – PALAGUA - CAIPAL Field in this study.

Graph 9



SOURCE: ANTEK S.A (November, 2009)

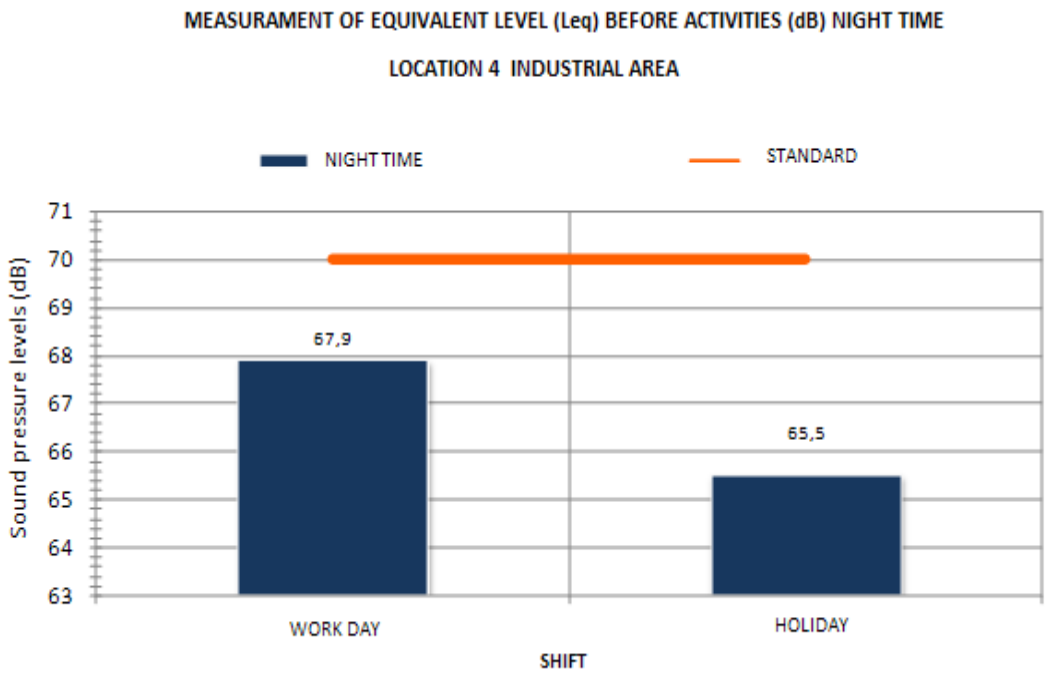
According to the graph it can be seen that the measurements for both the work day and the holiday are below the maximum limit established by the outstanding regulations, which means that they comply.

There is a significant difference between the equivalent level values of the two days, 69,5 and 60,3 dB, representing the work day and holiday respectively; due to this fact, it can be interpreted and deduced that the activities of a normal day (work day) influence the sound pressure levels of this point considerably.

6.2.4 Location 4 Industrial Area

Graph 10 shows the measurements of the nighttime equivalent level, reported during the monitoring performed at location point 4 of the analysis, for a work day and another for a holiday located at AP – PALAGUA - CAIPAL Field in the study.

Graph 10



SOURCE: ANTEK S.A (November, 2009)

As previously evidenced, the measurement taken at location point 4 during nighttime hours for both the work day and the holiday complies with the limit established in the outstanding regulations at a national level.

The maximum value was reported during the work day, with 67.9 (dB). However, the difference between this and the measurement taken on the holiday is not considerable. This may be due to the fact that the equipment and machinery operate 24 hours a day, either on work days or on holidays.

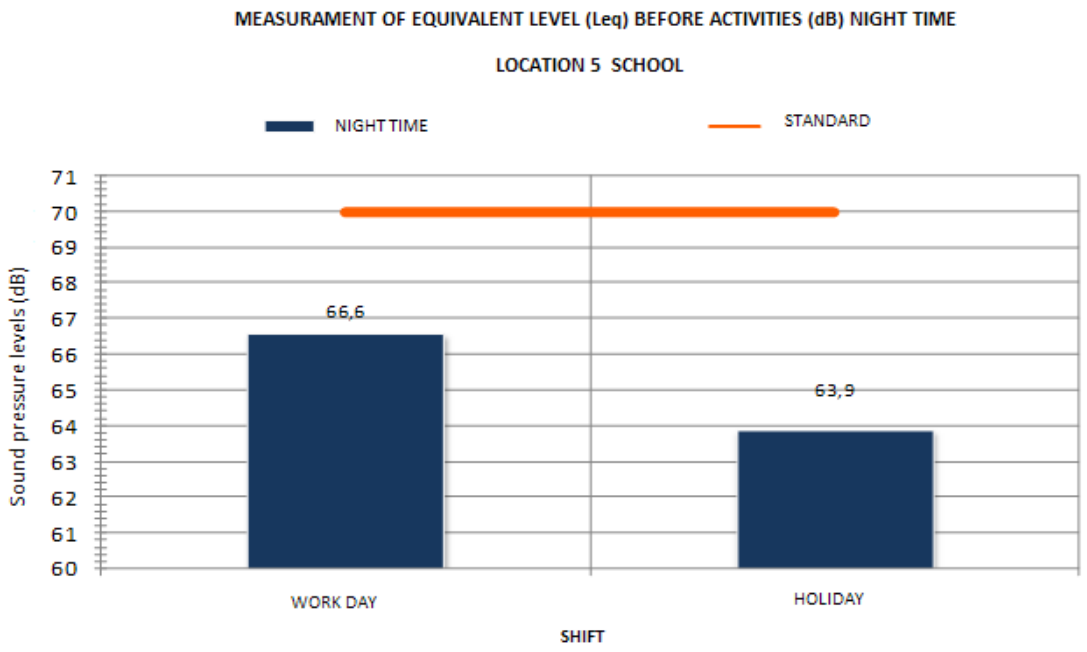
Illustration 5

SOURCE: ANTEK S.A. (November, 2009)

6.2.5 Location 5 School

Graph 11 shows the measurements of the nighttime equivalent level, reported during the monitoring performed at location point 5 of the analysis, for a work day and another for a holiday located at the AP – PALAGUA - CAIPAL Field in the study.

Graph 11



SOURCE: ANTEK S.A. (November, 2009)

As it can be observed in the graph, the measurement taken at location point 5 during the nighttime hours corresponding to work days as well as those corresponding to a holiday comply with the limit established in the effective regulations at national level.

The maximum value was registered during the work day, with 66.6 (dB). This value does not establish a great difference with the measurement obtained from the holiday; although the equivalent level is reduced in a small quantity. This can be due to the fact that the activitiesof the work day do not influence significantly the sound pressure levels of this point.

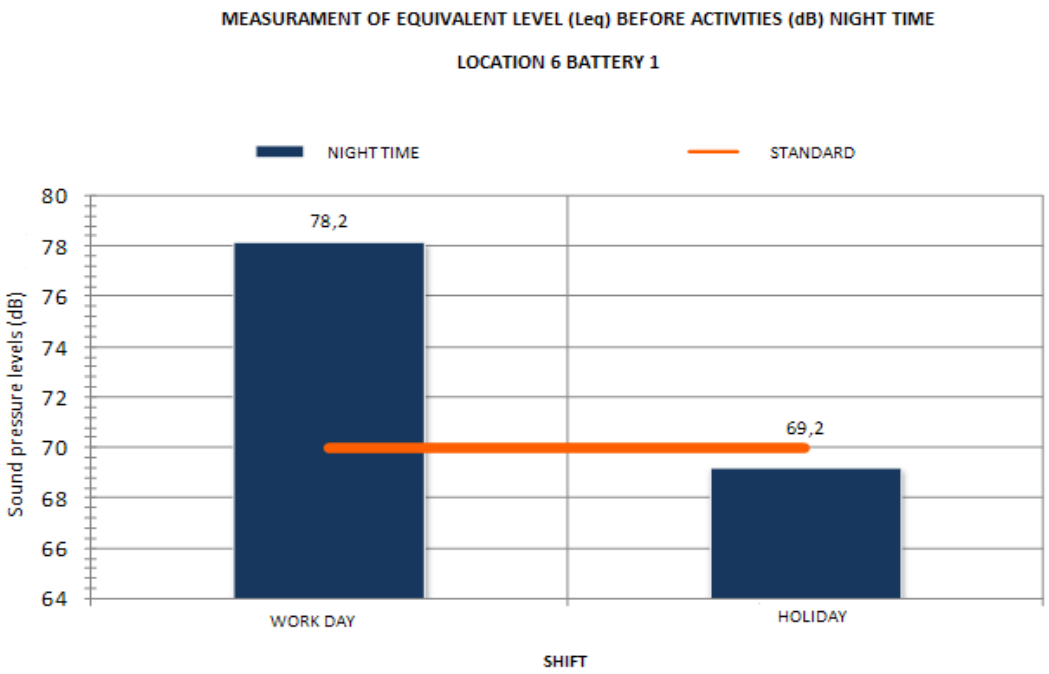
Illustration 6

SOURCE: ANTEK S.A. (November, 2009)

6.2.6 Location 6 Battery 1

Graph 12 shows the measurements of the nighttime equivalent level, reported during the monitoring performed at location point 6 of the analysis, for a work day and another for a holiday located at AP – PALAGUA - CAIPAL Field in the study.

Graph 12



SOURCE: ANTEK S.A. (November, 2009)

As previously evidenced, for Point 6 the measurement of the work day is the one that registers the greater value with 78.2 (dB), which exceeds the maximum limit allowed by the effective regulations; however, this can be explained since the machinery work day days 24 hours a day.

The Holiday presented a lower value with 69.2 (dB), which complies with the regulations and is very different to the value of the Work day, that is, work dayactivities greatly influence the sound pressure levels of this point.

7. CONCLUSIONS

The monitoring of environmental noise at the PA (Production Area) PALAGUA - CAIPAL Field corresponding to the possible punctual sources of emission during the production and operation activities allows establishing:

- That all the location points monitored during the daytime measurements in a work day and during a holiday are complying with the maximum limit established in Resolution 627/06 article 17 SECTOR C: restricted medium noise.

- Some of the location points monitored (Points 1, 2, and 6) during the nighttime measurements registered values that exceed the maximum limit established in resolution 627/06 article 17 SECTOR C: restricted medium noise.

- In the majority of the location points monitored during the daytime and nighttime measurements, for a work day as for a holiday, an increase of the equivalent levels in the nighttime measurements was evidenced, due mainly to the presence of elevated animal populations that live in the area.

8. BIBLIOGRAPHY

MINISTERIO DE AMBIENTE, VIVIENDA Y DESARROLLO TERRITORIAL. Resolución 0627 de 2006.

HARRIS, CYRIL M. Manual de medidas acústicas y control del ruido. Vols. 1 y 2. Mc Graw Hill. Tercera edición. 1995.

RECUERO LÓPEZ, MANUEL. Ingeniería Acústica. Paraninfo. España 2000.

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RESULTS TABLE OF SOUND PRESSURE LEVELS

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RESULT TABLES SOUND PRESSURE LEVEL

STL DAY SHIFT - WORK DAY

LOCATION 1

MEASUREMENT OF NIGHTTIME SOUND PRESSURE LEVELS BEFORE ACTIVITIES, PALAGUA - CAIPAL FIELD - OIL WELL CAIPAL 10

November 9, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º07'19,6" 74º30'00,4"	09:15	6'	50,5	78	81,3	46,1	39,2	61,8	56,1	55,7	54,8	**57,7**	**58,9**	**75,0**
		EAST		09:04	6'	59,1	75,1	61,4	55,8	36,5	60,1	59,8	59,1	58,2			
		SOUTH		09:27	6'	61,7	85,7	74,5	57,6	38,7	65,8	61,9	59,8	58,8			
		WEST		09:33	6'	59,9	87,6	65,3	57,6	37,1	60,9	60,6	59,8	59			
		VERTICAL		09:39	6'	57.3	97,2	85,8	57	38,3	59,7	58,4	58,3	57,1			

SOURCE: ANTEK S.A. (November, 2009)

SPL DAY SHIFT - HOLIDAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES PALAGUA - CAIPAL FIELD - OIL WELL CAIPAL 10

November 8, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º07'19,6" 74º30'00,4"	13:15	6'	57,6	92,2	64,8	54,9	38,1	58,4	57,9	57,4	57	**56,7**	**56,8**	**75,0**
		EAST		13:21	6'	57,1	95,5	67,3	55,9	38	58,4	57,8	56,7	56,3			
		SOUTH		13:27	6'	56,1	98,4	65	55,2	36,9	56,8	56,4	56	55,.6			
		WEST		13:33	6'	56,4	83,8	59,7	55,6	38,4	56,9	56,8	56,4	56			
		VERTICAL		13:39	6'	56,5	90	59,7	55,3	37	57,3	57	56,4	55,8			

SOURCE: ANTEK S.A. (November, 2009)

SPL NIGHT SHIFT - WORK DAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES , PALAGUA - CAIPAL FIELD - OIL WELL CAIPAL 10

November 9, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º07'19,6" 74º30'00,4"	21:08	6'	70,9	94,7	77,2	66,9	49,2	73,1	72,7	70,7	68,4	**71,5**	**71,5**	**70,0**
		EAST		21:14	6'	71,6	95,6	75,2	67,9	48,3	73,6	73,3	71,5	69,2			
		SOUTH		21:20	6'	71,6	86,4	74,4	68,1	47,9	73,5	73,2	7,14	69,2			
		WEST		21:26	6'	71,7	95,2	74,8	67,8	48,1	73,7	73,5	7,15	69,3			
		VERTICAL		21:32	6'	71.5	84,6	74,7	67,4	48,4	73,5	73,2	71,3	69,2			

SOURCE: ANTEK S.A. (November, 2009)

NIGHT SHIFT -HOLIDAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES , PALAGUA - CAIPAL FIELD - OIL WELL CAIPAL 10

November 8, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º07'19,6" 74º30'00,4"	21:06	6'	55,5	77,0	56,8	54,5	35,8	56,2	56,0	55,5	54,9	**55,3**	**55,4**	**70,0**
		EAST		21:12	6'	56,1	70,3	56,6	55,9	35,6	56,5	56,4	56,2	56,0			
		SOUTH		21:24	6'	56,3	90,8	62,3	54,7	36,6	58,7	57,2	55,7	55,2			
		WEST		21:30	6'	54,1	90,1	65,1	55,4	37,1	57,6	57,4	56,8	56,0			
		VERTICAL		21:36	6'	54,7	92	64,9	54,0	37,4	57,9	57,5	56,6	55,9			

SOURCE: ANTEK S.A. (November, 2009)

LOCATION 2

SPL DAY SHIFT - WORK DAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES, PALAGUA - CAIPAL FIELD - WORKOVER LA PIA

November 9, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º 05' 56,00" 74º 31' 05,8"	09:55	6'	72,8	108,9	88,9	57,2	54,0	76,0	75,0	72,9	59,9	**72,3**	**72,4**	**75,0**
		EAST		10:01	6'	71,4	96,8	78,3	69,4	50,5	72,3	72,1	71,5	70,4			
		SOUTH		10:07	6'	71,9	89,2	76,2	66,3	53,4	73,2	72,9	72,1	68,3			
		WEST		10:13	6'	72,2	91,06	75,9	70,7	50,8	73,1	72,9	72,1	71,6			
		VERTICAL		10:19	6'	73,3	104,3	88,7	64,7	52,2	76,8	74,4	71,7	69,3			

SOURCE: ANTEK S.A. (November, 2009)

SPL DAY SHIFT - HOLIDAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES, PALAGUA - CAIPAL FIELD - WORKOVER LA PIA

November 8, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º 05' 56,00" 74º 31' 05,8"	14:00	6'	66,5	102,9	77,9	58,8	46,1	68,3	68,1	65,3	59,3	**67,9**	**67,9**	**75,0**
		EAST		14:06	6'	68,4	99,2	77,5	59,3	45,8	73,4	72,7	67,7	60,2			
		SOUTH		14:12	6'	68,6	94,6	77	59,4	46,2	74,2	73,6	66,6	60,2			
		WEST		14:18	6'	67,3	93,3	75,6	58,9	47,6	72,8	59,4	66,7	59,7			
		VERTICAL		14:24	6'	68,5	94,3	77,4	59,3	47	73,9	73	67,3	59,9			

SOURCE: ANTEK S.A. (November, 2009)

SPL NIGHT SHIFT - WORK DAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES, PALAGUA - CAIPAL FIELD - WORKOVER LA PIA

November 9, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º 05' 56,00" 74º 31' 05,8"	21:45	6'	68	94,6	74,3	65,1	47,4	70,3	69,8	67,7	66,5	**68,2**	**68,2**	**70,0**
		EAST		21:51	6'	68,9	96	78,6	65,7	45,9	70,5	70,6	68	66,6			
		SOUTH		21:57	6'	68,3	96,2	73,5	65,3	46,3	70,4	70,3	68	66,1			
		WEST		22:03	6'	68,1	95,3	74,8	65,1	48,1	70,1	69,9	67,7	66,3			
		VERTICAL		22:09	6'	67,8	100,7	76,3	65	47	69,9	69,6	67,5	66,3			

SOURCE: ANTEK S.A. (November, 2009)

SPL NIGHT SHIFT- HOLIDAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES, PALAGUA - CAIPAL FIELD - WORKOVER LA PIA

November 8, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º 05' 56,00" 74º 31' 05,8"	21:54	6'	71,7	96,1	79,1	66,6	46,1	77,1	75,1	74	73,9	**71,3**	**71,4**	**70,0**
		EAST		22:00	6'	70,3	91,7	80,1	67,1	47,7	76,3	74,6	73,7	72			
		SOUTH		22:06	6'	71,5	98,1	79	67,2	46,9	73,2	72,4	71,6	68,9			
		WEST		22:12	6'	72,8	100,6	81,7	67,4	46,8	75,9	75,1	75	69,1			
		VERTICAL		22:18	6'	70,1	92,9	84,1	67,1	47	75	74,8	74,4	69,6			

SOURCE: ANTEK S.A. (November, 2009)

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LOCATION 3

SPL DAY SHIFT - WORK DAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES, PALAGUA - CAIPAL FIELD - BATTERY 2

November 9, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º05'06,7" 74º30'54,2"	10:50	6'	61,8	94,2	78,9	55,5	42,1	66,2	62,9	59,1	58	**64,7**	**68,0**	**75,0**
		EAST		11:01	6'	60	92,7	76,1	56,3	40,4	63,2	61,4	58,4	57,3			
		SOUTH		11:07	6'	71,2	96,9	80,4	56,2	42,4	78,5	76,8	61,9	57,3			
		WEST		11:13	6'	71,8	99,5	81,4	55,7	43,5	77,9	75,8	67,5	58			
		VERTICAL		11:19	6'	58,7	78,2	64,6	54,7	44,2	60,5	60	58,4	56,9			

SOURCE: ANTEK S.A. (November, 2009)

SPL DAY SHIFT - HOLIDAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES, PALAGUA - CAIPAL FIELD - BATTERY 2

November 8, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º05'06,7" 74º30'54,2"	14:45	6'	55,5	100	70,8	52,9	35,3	57,6	56	54,5	53,7	**56,7**	**56,8**	**75,0**
		EAST		14:51	6'	56	88	70,9	53,2	36,8	57,2	56,7	55,4	54,3			
		SOUTH		14:57	6'	58,7	99,9	77,2	53,7	38,2	59,7	58	55,8	54,7			
		WEST		15:03	6'	56,8	86,9	64,6	53	35,9	61,3	58,5	55,6	54,3			
		VERTICAL		15:09	6'	56,5	81,6	68,4	52,4	34,8	60,3	56,8	54,3	53,6			

SOURCE: ANTEK S.A. (November, 2009)

SPL NIGHT SHIFT - WORK DAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES, PALAGUA - CAIPAL FIELD - BATTERY 2

November 9, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º05'06,7" 74º30'54,2"	22:24	6'	69,5	95,4	77,7	65,2	50,7	71,2	70,8	69,3	67,9	**69,5**	**69,5**	**70,0**
		EAST		22:30	6'	69,9	84,2	74	65,7	49,9	71,7	71,3	69,8	68,3			
		SOUTH		22:36	6'	69,4	96,3	77,4	65,7	48,1	71,3	70,9	69,2	67,8			
		WEST		22:42	6'	69,3	96,2	77,3	65,1	48,3	71,1	70,6	69,2	67,8			
		VERTICAL		22:48	6'	69,4	99,3	77,1	64,8	48,8	71,1	70,8	69,2	67,9			

SOURCE: ANTEK S.A. (November, 2009)

SPL NIGHT SHIFT- HOLIDAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES, PALAGUA - CAIPAL FIELD - BATTERY 2

November 8, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º05'06,7" 74º30'54,2"	22:40	6'	59,6	93,9	82,7	55,8	36	60,9	60,6	60,1	59,9	**60,3**	**60,3**	**70,0**
		EAST		22:46	6'	60,1	93	72,1	57,9	37,3	61,2	61	61	60,9			
		SOUTH		22:52	6'	61,1	97	79,7	58,4	36,8	65,4	64,3	63,9	61			
		WEST		22:58	6'	60,3	96,5	86,3	58,5	36,1	73,6	71,1	70,1	64,5			
		VERTICAL		23:04	6'	60,4	93,2	82,7	58,4	36,9	64,7	63,8	62,9	61,1			

SOURCE: ANTEK S.A. (November, 2009)

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LOCATION 4

SPL DAY SHIFT - WORK DAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES, PALAGUA - CAIPAL FIELD - INDUSTRIAL AREA

November 9, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º05'01,5" 74º30'30,6"	11:30	6'	57,8	89,4	69,8	53,7	37,2	61,4	59	56,2	55,1	**59,9**	**63,3**	**75,0**
		EAST		11.36	6'	55,9	77,4	62	53,6	38,3	57,2	56,8	55,7	54,8			
		SOUTH		11:42	6'	56	76,4	65,3	53,4	38,6	57,9	56,9	55,4	54,5			
		WEST		11:48	6'	60,7	95,3	78,1	53,7	40,6	66,1	59,9	55,8	54,7			
		VERTICAL		11.54	6'	69,1	99,7	88,8	54,4	50,2	75,4	68,8	58,8	55,8			

SOURCE: ANTEK S.A. (November, 2009)

SPL DAY SHIFT - HOLIDAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES, PALAGUA - CAIPAL FIELD - INDUSTRIAL AREA

November 8, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º05'01,5" 74º30'30,6"	15:30	6'	57,1	97	69,4	54,7	35,8	59,5	57,6	55,8	55,1	**59,2**	**59,4**	**75,0**
		EAST		15:36	6'	61,4	113,4	81,6	54,6	39,7	60,1	58,5	56,2	55,3			
		SOUTH		15:42	6'	59,3	93,1	66,9	55	38,6	63,6	62,8	56,8	55,5			
		WEST		15:48	6'	59,5	98,5	70,7	54,6	39	65,2	61,9	56,3	55,4			
		VERTICAL		15:54	6'	58,5	105,7	77,7	54,2	38,8	61,8	59,5	55,7	55,0			

SOURCE: ANTEK S.A. (November, 2009)

SPL NIGHT SHIFT - WORK DAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES, PALAGUA - CAIPAL FIELD - INDUSTRIAL AREA

November 9, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º05'01,5" 74º30'30,6"	22:06	6'	68	81,3	70,5	66	40,1	69	68,8	68	67,3	**67,9**	**67,9**	**70,0**
		EAST		23:12	6'	68,2	88,1	77,2	65,3	42,2	69,2	68,9	68	67,2			
		SOUTH		23:18	6'	67,8	86,8	73,8	64,8	42	69	68,6	67,7	66,8			
		WEST		23:24	6'	66,9	80	70,3	64,3	42,4	68,7	68,4	67,7	66,9			
		VERTICAL		23:30	6'	68,4	91,4	75,3	65,4	42,6	70,7	69,4	68	67,1			

SOURCE: ANTEK S.A. (November, 2009)

SPL NIGHT SHIFT - HOLIDAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES, PALAGUA - CAIPAL FIELD - INDUSTRIAL AREA

November 8, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º05'01,5" 74º30'30,6"	23:15	6'	62,2	99,4	79,1	59,1	41,1	64,5	64,2	63,1	62,5	**64,8**	**65,5**	**70,0**
		EAST		23:21	6'	64,4	95,6	78,6	54,7	40,8	67,9	67,6	65,5	64,9			
		SOUTH		23:27	6'	64,1	89,4	78,3	60,6	39,9	66,4	66,1	65,9	65			
		WEST		23:33	6'	64,4	95,7	78,8	57,9	40,6	67,5	66,5	66	64,1			
		VERTICAL		23:40	6'	69,1	90	72,7	65,7	40,4	71,7	70,9	69,9	68,5			

SOURCE: ANTEK S.A. (November, 2009)

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LOCATION 5

SPL DAY SHIFT - WORK DAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES, PALAGUA - CAIPAL FIELD - SCHOOL

November 9, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º04'54,5" 74º30'30,2"	12:05	6'	60,2	91,4	71,7	54,4	37,8	65,9	62,8	57,8	56	**57,8**	**58,5**	**75,0**
		EAST		12:11	6'	55,6	89,7	68	53,1	37,6	57,5	56,8	55,2	54,2			
		SOUTH		12:17	6'	61,3	88,2	73,5	52,9	36,9	66,4	63,5	57,8	54,9			
		WEST		12:23	6'	55,8	88,6	75,8	51,7	37,9	57	56,5	55	53,8			
		VERTICAL		12:29	6'	56	95,9	74,8	52,8	36,8	67,6	57	55,3	54,1			

SOURCE: ANTEK S.A. (November, 2009)

SPL DAY SHIFT - HOLIDAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES, PALAGUA - CAIPAL FIELD - SCHOOL

November 8, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º04'54,5" 74º30'30,2"	16.12	6'	57,6	92,5	61,4	54,8	35,7	59,3	58,9	57,4	56,4	**56,6**	**56,6**	**75,0**
		EAST		16:18	6'	56,3	73,7	58,9	54,2	36,2	57,8	57,4	56,2	55			
		SOUTH		16:24	6'	56,5	80,7	58,9	54,8	36,1	58	57,7	56,3	55,5			
		WEST		16:30	6'	56,5	74,6	59	53,9	36,5	58	57,6	56,3	55,2			
		VERTICAL		16:36	6'	55,9	77,6	59,3	54,1	36,4	57,6	57	55,8	54,8			

SOURCE: ANTEK S.A. (November, 2009)

SPL NIGHT SHIFT - WORK DAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES, PALAGUA - CAIPAL FIELD - SCHOOL

November 9, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º04'54,5" 74º30'30,2"	23:46	6'	66,3	86,3	68	65,4	40,1	67,3	67,1	66,4	65,9	**66,6**	**66,6**	**70,0**
		EAST		23:52	6'	66,3	83,6	67,6	65,3	42,2	67	66,9	66,3	65,8			
		SOUTH		23:58	6'	66,7	90,1	68,9	65,7	42	67,6	67,3	66,5	66,1			
		WEST		00:04	6'	66,8	89,9	69,4	65,7	42,4	67,5	67,3	66,7	66,2			
		VERTICAL		00:10	6'	66,9	92,3	77,8	65,7	42,6	68	67,8	67,5	66,9			

SOURCE: ANTEK S.A. (November, 2009)

SPL NIGHT SHIFT - HOLIDAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES, PALAGUA - CAIPAL FIELD - SCHOOL

November 8, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º04'54,5" 74º30'30,2"	23:52	6'	63,1	84	78,9	60,6	40,6	64,8	64,2	64	62,9	**62,7**	**63,9**	**70,0**
		EAST		23:58	6'	63	80,7	81,2	59,9	39,9	64,4	64,3	62,9	60,1			
		SOUTH		00:04	6'	62,2	84,8	84,4	55,9	42,8	63,7	63,4	63,1	61,1			
		WEST		00:10	6'	57,4	82,8	79,7	55,7	39	58,9	58,6	58,1	57,4			
		VERTICAL		00:16	6'	67,8	82,2	83	65,6	39,7	70,2	69,8	69,4	66,5			

SOURCE: ANTEK S.A. (November, 2009)

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LOCATION 6

SPL DAY SHIFT - WORK DAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES, PALAGUA - CAIPAL FIELD - BATTERY 1

November 9, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º04'45,9" 74º30'21,2"	12:45	6'	58,1	99,8	77,7	54,8	38,4	60,1	59,4	56,9	56	**58,3**	**58,4**	**75,0**
		EAST		12:51	6'	58,1	85,7	68,8	54,9	38,3	61,1	59,2	56,8	56			
		SOUTH		12:57	6'	59,6	103,6	80,4	55,2	38,7	61,8	59,3	57,1	56,3			
		WEST		13:03	6'	58	84,4	67,1	54,4	37,4	60,7	59,8	57,4	56,3			
		VERTICAL		13:09	6'	57,8	98,8	80,9	54,1	41,6	59	57,8	56,4	55,7			

SOURCE: ANTEK S.A. (November, 2009)

SPL DAY SHIFT - HOLIDAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES, PALAGUA - CAIPAL FIELD - BATTERY 1

November 8, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º04'45,9" 74º30'21,2"	16:54	6'	57,2	93,4	69,1	55,8	37,8	57,9	57,4	56,8	56,4	**58,1**	**58,2**	**75,0**
		EAST		17:00	6'	59,1	98,5	69,6	56,3	37,1	63,9	61,6	57,2	56,8			
		SOUTH		17:06	6'	58	100,7	68,6	55,7	36,4	60,8	58,9	57	56,5			
		WEST		17:12	6'	56,7	85,5	60,6	55,3	37,2	57,9	57,6	56,4	56			
		VERTICAL		17.18	6'	59,4	109,8	76,7	55	37,4	63,4	58,7	56,2	55,6			

SOURCE: ANTEK S.A. (November, 2009)

SPL NIGHT SHIFT - WORK DAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES, PALAGUA - CAIPAL FIELD - BATTERY 1

November 9, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º04'45,9" 74º30'21,2"	00:24	6'	78,1	85,1	82	75	53,1	79,9	79,5	77,9	76,5	**78,1**	**78,20**	**70,0**
		EAST		00:30	6'	78,2	80,6	81,1	75,7	52,8	79,8	79,5	78,1	76,8			
		SOUTH		00:36	6'	78,1	83,2	81,6	75,5	52,2	79,8	79,4	77,4	76,6			
		WEST		00:42	6'	79,3	99,2	94,7	74,8	56,8	80,1	79,4	77,7	76,5			
		VERTICAL		00:48	6'	77	89,5	79,9	73,7	49,9	78,9	78,3	77	74,8			

SOURCE: ANTEK S.A. (November, 2009)

SPL NIGHT SHIFT - HOLIDAY

MEASUREMENT OF SOUND PRESSURE LEVELS NIGHT SHIFT. BEFORE ACTIVITIES, PALAGUA - CAIPAL FIELD - BATTERY 1

November 8, 2009

EMISSION	DISTANCE (METERS)	MICROPHONE POSITION	COORDINATES	Time	Sampling time (min)	LEQ (L)	LPK	L MAX	L MIN	TWA	L 5	L 10	L 50	L 90	PONDERED LEQ	EQUIVALENT READING LEVEL dB (A)	MAXIMUM PERMISSIBLE STANDARD
SPL Leq emission	0,0 m	NORTH	06º04'45,9" 74º30'21,2"	00:26	6'	69,1	95	75,3	66,1	48,4	71,3	69,9	68,7	66,1	**69,2**	**69,2**	**70**
		EAST		00:32	6'	69,8	96,1	79,6	66,7	47,6	71,5	71,6	69,9	67,2			
		SOUTH		00:38	6'	69,3	92	74,5	66,3	46,9	71,4	71,3	69	66,9			
		WEST		00:44	6'	69,1	94,1	75,8	66,1	47,1	71,1	70,9	68,9	66,3			
		VERTICAL		00:48	6'	68,8	89,7	77,3	65	48	69,9	69,4	67,2	65,1			

SOURCE: ANTEK S.A. (November, 2009)

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Attachement 2

PHOTOGRAPH RECORD

LOCATION POINTS MONITORED AT THE PRODUCTION AREA PALAGUA - CAIPAL OIL FIELD

Location 1 Well Caipal 10

DAY SHIFT - WORK DAY

DAY SHIFT - HOLIDAY

NIGHT SHIFT- WORK DAY

NIGHT SHIFT - HOLIDAY

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Location 2 Workover Pia

DAY SHIFT - WORK DAY

DAY SHIFT - HOLIDAY

NIGHT SHIFT - WORK DAY

NIGHT SHIFT - HOLIDAY

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Location 3 Battery 2

DAY SHIFT - WORK DAY

DAY SHIFT - HOLIDAY

NIGHT SHIFT - WORK DAY

NIGHT SHIFT - HOLIDAY

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Location 4 Industrial Area

DAY SHIFT - WORK DAY

DAY SHIFT - HOLIDAY

NIGHT SHIFT - WORK DAY

NIGHT SHIFT - HOLIDAY

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Location 5 School

DAY SHIFT - WORK DAY

DAY SHIFT - HOLIDAY

NIGHT SHIFT- WORK DAY

NIGHT SHIFT - HOLIDAY

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Location 6 Battery 1

DAY SHIFT - WORK DAY

DAY SHIFT - HOLIDAY

NIGHT SHIFT- WORK DAY

NIGHT SHIFT - HOLIDAY

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Attachment 3.

CERTIFICATES OF CALIBRATION