SOME ASPECTS REGARDING NOISE POLLUTION

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Wondering what the main purpose of our modern civilization is, we can say with boldness that this task - improves the quality of human life, make life more comfortable. In this context environmental security issues, conservation and more efficient use of the natural resources are the main objectives (unfortunately these objectives can not be met by all the people on the globe) in achieving the aforementioned goal. In this order, priorities for the current stage of development of human civilization in the last decade have essential changed, if in the past the main tendency of technology was "*more, faster, higher*" now replaced by new ones, a trend which is "*better, safer, quieter*".

Among the global problems of modern ecology (Greenhouse affects, water quality, ozone, air pollution, radioactive waste, etc.) noise pollution problem was not always taken into consideration. In the following we try to show that noise pollution is a serious problem for ecology, so globally every second person feels the harmful effects of noise pollution, which in some cases may even be more harmful than ozone depletion or acid rain exposure.

Large-scale introduction of new advanced technologies in industry, increased capacity and operation-speed of equipment, widespread use of land, air and naval transport, development and use of a variety of household equipment and facilities - all these factors led to that man is under repeated exposure to noise harmful to health at work, home, on vacation, while traveling, that means with technological progress we assist to acoustical expansion with social, health and economic negative impact.

Social impact on human life as told R. Taylor: "Man has reached a high level of civilization, particularly to its capacity to communicate through sound - one of the main forms of human communication. But noise prevents this communication, impoverishes our lives, reduce the normal everyday human activities", famous German philosopher, Schopenhauer believed that "… human sensitivity to external noise, obviously, is proportional to his intelligence".

From the medical point of view increased noise affecting the nervous and cardiovascular system, causing irritation, fatigue, aggression, etc. Illnesses associated with exposure to noise and vibration occupies first position among all professional diseases. According to Russian scientists, these diseases in Russia reached more than 35% of all occupational activities. At the moment there are tens of millions of workers and hundreds of millions in urban residents exposed to harmful noise.

Regarding economic aspect is known that noise has a negative impact on labor productivity. For example, worker productivity at work exposed to a noise level of 80 dBA will begin to decline by 1% each increase in noise by 1-2 dBA. Economic losses due to high noise levels at work in developed countries reach tens of billions of dollars annually. Nowadays, to obtain a competitive final product on the market, in addition to high quality, low price this product must be silent. In this case, less noisy machines, aggregates, installations are generally more expensive - each decrease by 1 dBA of emitted noise lead to rises by about 1% of the final product price. For example silent compressors are about 40% more expensive than usual compressors; in modern aircraft noise insulation costs represent 25% of the final product and sound insulation in cars represent 10% of the car final price.

According to some estimates, the cost of all operations against noise only for Western European countries amounted to 38 billion € per year, or almost 1% of GDP. This is not surprising, given that the cost of an acoustic environmental screen km costs nearly 1 million U.S. $. However, despite these very high costs only in European Union 130 million people are exposed to noise levels that exceed acceptable limits, causing anxiety and irritation and the worst case can lead to hearing loss. This means that the price paid currently for noise reduction is insufficient and, according to experts, should be 2-3 times higher.

From the foregoing, that reduction problem, reducing of noise pollution is a very important ecological issue. According to some estimates, over 60% of the population living in cities is exposed to excessive noise levels, for example, equivalent sound levels in Beijing, Moscow, Hong Kong is about to 60-65 dBA, and in Mexico -70 dBA. These noise levels are very high, and because perception of sound is different and subjective from person to person, we can say that noise in urban areas often exceeds the allowable values 2-4 times. Table 1 show the evolution in time and reducing of the acoustical pollution.

Table 1 Evolution of noise in time.

Object	**Level dBA, (1950-1960)**	**Level dBA, (1980-1990)**	**Level dBA present**
Jet aircraft	95-100	80-85	15
Cars	90-95	72-75	15-20
Trains	105-115	80-85	25-30
Tractor	95-100	75-80	20
Construction Machinery	95-105	80-85	15-20
Ship engine room	95-115	80-85	15-30
Lifts	60-70	40-50	20-30
Refrigerators	55-70	30-35	25-30
Air conditioners	80-85	45-50	35
Lathes, machine tools	95-100	85-90	10-15
Mobile compressor stations	95-100	75-85	15-20

It can still be made and other examples, but this shown in table 1 shows that in most areas over the past 30-40 years has been possible to reduce emitted noise by an average of 15-30 dBA, allowed the expansion noise limiting. However, there are currently in operation a large number of machines, facilities, transportation facilities (land, rail and sea), who's emission levels remained at the high level of noise pollution. So we can say that the achievements of past decades in reducing and mitigating noise give a good results (a decrease by ≈ 40 dBA), noise pollution problem still remains an actual issue.

Because of physiological and psychological factors that vary from person to person the same variation of noise may be perceived differently, by different people. In specialty terms, the minimum level of audibility threshold starting at 0 dB, and reaches maximum audibility threshold (pain) is 100-140 dB. This is an approximation of subjective human perception of noise and the scale variation of 1 dB relative variation is the same regardless of where we stay, and 1 dB is the smallest change we can detect. In other words a decrease of 1 dBA of noise is practically *insignificant* for human ears, a decrease by about 3 dBA is *already perceptible* to the ear, a decrease by 6 dBA is *obvious* to the ear, a reduction of 10 dBA is *significant* and a reduction of 30 dBA is *impossible*. However regarding the data in Table 1 we see that it is possible!

From Historically point of view, man has struggled with noise reduction since ancient times. In the famous "Epic of Gilgomeshe" great flood was considered "…as punishment of gods for high noise produced by people on earth ".In ancient Greece were made first attempts to create buffer zones to protect residents from noise, as townspeople of Sybaris have asked the authorities to move noisy production outside the protective city wall all. Rome was the most crowded and noisy city of the ancient world - the carts were the main source of noise. After the Roman writer Martial complained to authorities: "… *the noise that enters my house at night, sometimes I think that all Rome passes through my bedroom*". As a result, great Caesar banned carts passing through Rome at night.

In the XVI century King Henry VII of England forbade men to beat their wives at night to avoid disrupting the neighbors who sleep. But women cries in London were almost negligible compared to noise from urban transport! Famous English physician Thomas Moore said: "…*London blast during the day is awful*" - and this happens in the late XIXth century.

Beginning with late XIXth century - early XXth century, humanity begins to worry about decrease of noise pollution. Boston in 1850 adopted the first municipal act to combat noise. In 1898 in the city of Nuremberg was established the first public organization – "*The League against traffic noise*", in 1909 in London held the first conference regarding noise control, which was attended by representatives of eight countries.

Fighting against noise pollution began somewhere in the early 1920^{s} and can be divided into three distinct phases:

1) pre-war period (1920-1930);
2) post-war period (1950-1970);
3) the modern period (beginning in 1980 till present).

In the prewar period were made first devices for measuring noise level so-called sonometers, then began the quantitative study of noise sources, have taken the first steps in the study of sound insulation, sound absorption, sound propagation. Meanwhile, appear the first publications devoted to noise problems, even some handbooks, including the acoustic measurements (L. L. Myasnikov, USSR), general problems of noise control in buildings (A. Schoch, Germany) and others, also in Germany and the U.S. appear first sound magazines.

In middle of 1950 it was developed a new science “Aero-acoustics”. First national and international standards regarding noise control were adopted in the late 1960s, URRS in 1956 and USA in 1957, but maximum permissible noise levels are set by national or regional authorities.

Between, 1960-1970 many countries developed standards for noise and vibration. Over time, the number of Standards dramatically increased, and for the past 20 years, was released more than 50 international standards regarding methods of measuring noise of compressors, ventilation systems, turbines, machine tools, computers, etc.

Between, 1960-1970 many countries have adopted effective noise laws (acts, decrees, etc.), designed to reduce noise in industry. England was one of the first countries changed the law to fight more effectively with problems of noise, so in 1970 it adopted the first law on noise reduction and in 1974 - Pollution Control Law.

Modern period (1980-1990) in terms of reducing noise pollution is characterized primarily by using new technologies (laser), new types of vehicles (electric device), new ways of processing materials (ongoing), developing of new types of materials.

In conclusion we will try to define sound. Sound may be defined as any pressure variation (in air, water or other medium) that the human ear can detect. Just like dominoes, a wave motion is set off when an element sets the nearest particle of air into motion. This motion gradually spreads to adjacent air particles further away from the source. Depending on the medium, sound propagates at different speeds. In air, sound propagates at a speed of approximately 340 m/s. In liquids and solids, the propagation velocity is greater – 1500 m/s in water and 5000 m/s in steel.

In the other hand sound is such a common part of everyday life that we rarely appreciate all of its functions. It provides enjoyable experiences such as listening to music or to the singing of birds. It enables spoken communication and it can alert or warm us – for example, with the ringing of a telephone, or a wailing siren. Sound also permits us to make quality evaluation and diagnoses – the chattering valves of a car, a squeaking wheel, or a heart murmur.

Yet, to often in our modern society, sound annoys us. Many sounds are unpleasant and unwanted – these are called **noise**. However, the level of annoyance depends not only on the quality of the sound, but also our attitude towards it. The sound of his new jet aircraft taking off may be music to the ears of the design engineer, but will be ear-splitting agony for the people living near the end of the runway. A creaking floor, a scratch on a record, or a dripping tap can be just as annoying as loud thunder.

Worst of all, sound can damage and destroy. A sonic boom can shatter windows and shake plaster of walls. But the most unfortunate case is when sound damage the delicate mechanism designed to receive it – the human ear.

The most familiar instrument for measuring pressure variations in air is the barometer. However, the pressure variations which occur with changing weather condition are much too slow for the human ear to detect – and hence do not meet our definition of sound. But, if variations in atmospheric pressure occur more rapidly – at least 20 times a second – they can be heard and hence are called sound. (A barometer cannot respond quickly enough and therefore cannot be used to measure sound.)

The number of pressure variation per second is called the **frequency** of the sound, and is measured in **Hertz (Hz)**. The frequency of a sound produces it’s distinctive **tone**. Thus, the rumble of distant thunder has a low frequency, while a whistle has a high frequency. The normal range of hearing for a healthy young person extends approximately 20 Hz up to 20 kHz while the range from the lowest to highest note of piano is 27,5 Hz to 4186 Hz.

These pressure variation travel through any elastic medium (such as air) from the source of the sound to the listener’s ears. You probably already have some idea of the speed of sound from the familiar rule for determining how far away a thunder storm is: count 3 seconds per kilometer or 5 seconds per mile from the time you see the lightning until you hear the thunder. This time interval corresponds to a speed of sound in air of 1238 km/hour or 770 miles/hour. For acoustic and sound measurement purposes, this speed is expressed as 344 m/s at room temperature.

The second main quantity used to describe a sound is the size or **amplitude** of the pressure fluctuations. The weakest sound a healthy human ear can detect has an amplitude of 20 millionths of a

Pascal (20 µPa) – some 5000000000 times less than normal atmospheric pressure. A pressure change of 20 µPa is so small that it causes the eardrum to deflect a distance less than the diameter of a single hydrogen molecule. Amazingly, the ear can tolerate sound pressures more than million times higher. Thus, if we measured sound in Pa, we would end up with some quite large, unmanageable numbers. To avoid this, another scale is used – the **decibel** or **dB scale**.

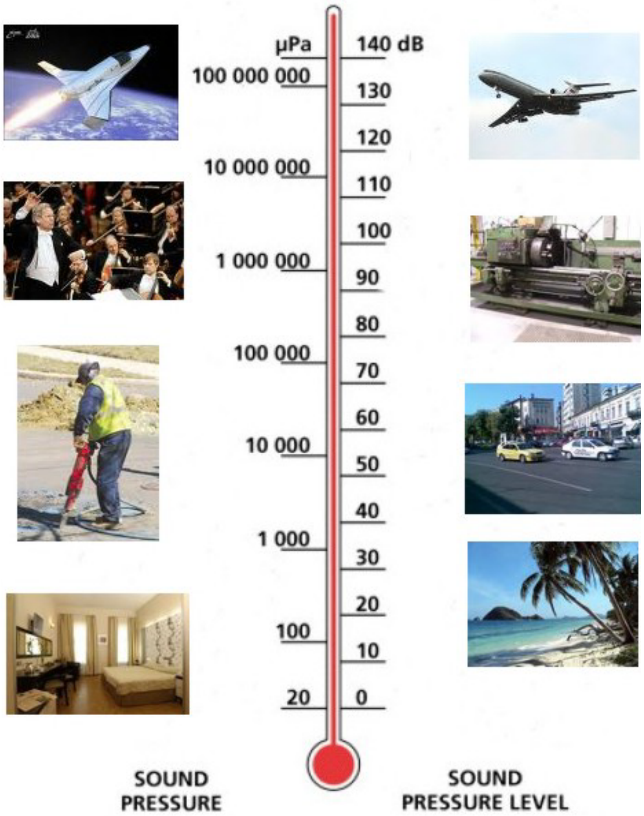

Figure 1. Transformation scale of acoustic pressure into decibel (dB)

The decibel is not an absolute unit of measurement. It is a ratio between a measured quantity and an agreed reference level. The dB scale is **logarithmic** and uses the hearing threshold of 20 µPa as the reference level. This is defined as **0 dB**. When we **multiply** the sound pressure in Pa by 10, we **add** 20 dB to the dB level. So 200 µPa correspond to 20 dB, 2000 µPa to 40 dB and so on. Thus, the dB scale compresses a range of a million into a range of only 120 dB. The **sound pressure levels (SPL)** in dB and Pa of various familiar sounds are shown in the figure 3.

One useful aspect of the decibel scale is that it gives a much better approximation to the human perception of relative loudness than the Pascal scale. This is because the ear reacts to a logarithmic change in level, which corresponds to the decibel scale 1 dB is the same relative change everywhere on the scale.

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Recomandat spre publicare: 12.03.2010.