THE MANAGEMENT OF EMERGING NOISE REDUCTION TECHNIQUES IN WORKPLACE ENVIRONMENT

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ABSTRACT

The paper reviews relevant and related literature on emerging noise reduction techniques in the workplace environment in order to provide a conceptual framework that will assist the attainment of elimination of noise at the source in the Nigerian workplace environment. However the economic approach to health and safety at workplace environment cannot replace the value of human requirements, as reduction in quality of life is difficult to be evaluated in monetary terms. The research design adopted is the exploratory research which gave an insight into the variables to look for in the next aspects of the research. Development is important because it can be a practical tool for teaching cooperation between the management and employees in concrete ways. The study reveals that the modern technique which aligns with international best practice added value to production operations. Since noise reduction at the source during the design stage of workplace environment led to the reduction of health hazards, improved communication gap amongst workers thereby enhancing the level of productivity to an optimum level. In conclusion, we can emphatically say that of all the measures of noise control, the elimination of noise at the source that is directly on the apparatus, machine or mechanism is most effective.

Keywords: Development, Noise Reduction, Workplace, Environment.

1. INTRODUCTION

Workplace noise is becoming a “nuisance” and measures have to be taken to reduce it or at least control it. It is hampering the physical and mental health of the workers and is alienating them from the society. In today’s workplace, workers all over the world are faced with a multitude of health hazards such as noise control which invariably affect productivity due to absenteeism occasioned by ill health (Kadiri, 2002:79). A healthy workplace is an environment where health risks are recognized and controlled if they cannot be eliminated. In a healthy workplace, the work is designed to be compatible with people’s health needs and limitations, and employees and employers recognize the responsibility they bear to their own health and the health of their colleagues (Willis, 2001: 44-46). Occupational safety and Health Administration (OSHA) and Factory Act requires employers to have an ongoing system for the identification of existing and potential risks to the health or safety of workers at their place of
employment and the measures, including procedures to respond to an emergency, that will be taken to reduce, eliminate or control those risks. The risk management system need not be separated from operational procedures. To ensure accountability, responsibility must be assigned to specific employees. Knowledgeable supervisors in consultation with experienced workers, are good candidates for leading hazard identification, assessment and control (Fair, 2005:62-68). The workers, are a valuable source of information about hazards and risks in the workplace.

All levels of management must be involved in the activities. Each level of management must be held accountable for all specific safety responsibilities, which cannot be delegated downward. To be most effective, the focus of management’s safety efforts should be on hazard control; the control of hazards at the workplace requires the application of good, sound, basic management skills (Johnson, 2004:55-57). Recounting the history of industrial revolution in the 18th century as it concerns safety and quality performance, Olusanya (2007:87) asserts that the introduction of safety system improved performance further by providing assurance that technology and standards were applied consistently.

The word noise comes from the Latin word nauseas meaning seasickness. It is defined as an excessive, displeasing human, animal or machine-created an environment that disrupts the activity or balance of human or animal life. The unwanted sound is called noise. In the workplace, contemporary active noise reduction can be achieved by the use of modern techniques using computers. The computer examines and identifies the waveform and wavelength of the noise, then generates the polarization and reverses waveform so that interference can be achieved. This process creates the desired result of destroying noise. This active noise reduction technique which came up as an emerging technology is different from any other process of noise control method earlier used.

Adeyemi (2008:67) asserts that insulation and sound absorbing tiles are mechanical ways of controlling the noise. He went further to say that there are reasons behind using an active noise control method when compared to all the other methods because it requires less equipments and lesser power. It works very well on lesser frequencies and in case of a single user.

In the most narrow sense, sounds are considered as noise pollution if they adversely affect human activity, or are capable of damaging physical structures on a regular repeating basis (Gosh and Kumar 2007:58). Dorman (2002:97) argues that noise contaminants are not physical particles, but rather waves that interfere with naturally occurring waves of a similar type in the same environment.

The causes of noise in the workplace probably originated with the invention of machines; such as boilers, plumbing equipment, air conditioners, generators and fans amongst others. They contribute to noise pollution to some extent. Noise created by people in public places too is a major contributor.

The study of acoustic ecology began in the late 1990s but it has just recently been recognized as a useful means for determining the safety and health of workers in the workplace (Krause, 2003:167). During this study, it was concluded that the most readily observed effect was harm to hearing and/or deafness due to damage to the sensory cells of the inner ear and adjacent nerve endings and their cells. Disorientation, nausea and signs of alarm were also common responses. Kavaller (2005:241) also called attention to the study of the little cotton rat which “however fragmentary, is one of the few that to date considers the possible effect of noise on the ecosystem of an area”. The study compared a population in a high noise corridor to a population a few hundred feet away. The study revealed that the little cotton rats closer to the airport were less social than their counterparts farther from the noise and researchers thus concluded that noise was the cause of “general behaviour differences between the two groups”.

In the workplace, noise pollution is generally a problem once the noise level is greater than 55dB(A). Selected studies show that approximately 35 to 40% of workers in office settings
find noise levels from 55 to 60 dB(A) to be extremely irritating (Kryter, 2010:120). However, if the noise source is continuous, the threshold level of tolerance amongst office workers actually becomes lower than 55 dB(A).

In Nigeria, workplace noise regulations usually specify a maximum outdoor noise level of 60 to 65 dB(A), while occupational safety organizations recommend that the maximum exposure to noise is 40 hours per week at 85 to 90 dB(A) (Chiltern District Council, 2007:12-13). For every additional 3 dB(A), the maximum exposure time is reduced by a factor 2, example 20 hours per week at 88 dB(A). Sometimes, a factor of two per additional 4 dB(A) is used. However, these occupational regulations are acknowledged by the health literature as inadequate to protect against hearing loss and other health effects.

In the United States, the Environmental Protection Agency (EPA) has not set any restrictions on limits to the level of noise. Rather, it has provided a list of recommended levels in its Noise Control Ordinance, which was published in 1975. This noise control is not funded by the Federal government in part because of the disagreements in establishing causal links between sounds and health risks, since the effect of noise is often psychological (Passchier, 2000:183). For instance, hearing loss could be attributed to a variety of factors including age, rather than solely due to excessive exposure to noise (Kryter, 2001:37).

The challenge of noise in the workplace is posing to be a big challenge with every passing day and is a threat to safety and health of the people who are working in the environment. It has been scientifically proven that noise more than 85 decibels can cause hearing impairment and does not meet the standards set for a healthy working environment (Olusanya, 2007:76). According to Veitch (2002:128), the general impact of noise includes headaches, irritability, insomnia, the reduction in sexual desire and loss of appetite. His findings affirmed to that of Ward and Sudefeld, (2003:179) which revealed that noise results in tension, uncertainty, faster talking, decrease in information interaction, poor scholastic performance and decreased likelihood of caring for the area’s surroundings.

However, the traditional definition of noise is “unwanted or disturbing sound”. Sound becomes unwanted when it either interferes with normal activities such as sleeping, conversation, or disrupts or diminishes one’s quality of life (http://www.noiseorg/library 2007). The fact that you can’t see, taste or smell it may help explain why it has not received as much attention as other types of pollution, such as air pollution, or water pollution. The air around us is constantly filled with sounds, yet most of us would probably not say we are surrounded by noise.

The standard parameters of noise must be observed and maintained at all workplaces in the manufacturing industries as maximum permissible limit values. For high audio frequencies, which are most harmful and unacceptable to the human ear, the standard sets lower levels of sound pressure as against sounds of lower audio frequencies. The length of exposure and character of noise can be accounted for by using correction tables that supplement the basic rates under the standard.

Approximate estimation of noise levels can be done by measuring the general noise level with a sound-level meter switched on scale A. In this case, the rated parameter is the equivalent loudness of sound in decibels with a designation A (dB (A)]. The maximum permissible levels of sound pressure (dB) and loudness levels, in b (A), for permanent workplaces within industrial premises and in the open production grounds are listed in Table 1. It should be noted that the maximum permissible limits of noise for various kinds of workplaces, as set by the standard, are based on the character of work not on the type of equipment.

Work zones in which the loudness level exceeds 85 dB must be noted with danger signs, and the workers be provided with personal protective equipment. Presence (even short-stay) of persons in the work zones where the levels of sound pressure measured in any active band exceed 135 dB is prohibited (Dorman, 2001:196).
Table 1: Standard Requirements for Industrial Noise Levels

The standardized parameters for noise are the level of sound pressure, the sound loudness level, the equivalent (effective) loudness level, and the frequency.

<table>
<thead>
<tr>
<th>Workplace office, lab. Facilities; first-aid and health centers, etc.</th>
<th>Octave band geometric mean frequencies, Hz</th>
<th>Apparent and equivalent loudness level, db (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>63</td>
<td>125</td>
</tr>
<tr>
<td>Sound pressure level, db</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design office, lab. Facilities; first-aid and health centers, etc</td>
<td>71</td>
<td>61</td>
</tr>
<tr>
<td>Managerial office</td>
<td>79</td>
<td>70</td>
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<tr>
<td>Observation and remote control cabins: without intercom with intercom precision assembly room; Typing office</td>
<td>94</td>
<td>87</td>
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<tr>
<td></td>
<td>83</td>
<td>74</td>
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<tr>
<td>Experimental Laboratory; “noisy” computer rooms</td>
<td>94</td>
<td>87</td>
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<td></td>
<td>83</td>
<td>74</td>
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<tr>
<td>Open ground</td>
<td>99</td>
<td>92</td>
</tr>
</tbody>
</table>

Source: Polter, 2003:123

2. RESEARCH METHODOLOGY

The research design adopted is the exploratory research which is aimed at providing preliminary information analysis that will give insight into the main things (factors or variables) to look for in the next aspect of the research which should be more detailed. The aim of this research design is to gain familiarity with a phenomenon or to achieve new insights into it.

3. FINDINGS

Findings reveal that the specifications found in modern techniques use for noise reduction include sound octave-band pressure levels (band pressure levels) measured at a certain distance from the machine, and sound loudness levels, at a meter from the machine. The survey conducted shows that with the modern techniques, in designing a new workplace environment, it is obligatory that the acoustic analysis be made for specified points enclosures to ensure safe levels of sound pressure. The objectives of the acoustic analysis are to:

- Determine the sound pressure levels at specified points, given the source of noise and its noise characteristics;
- Establish the extent to which loudness of noise should be reduced; and
- Assign measures aimed at reducing excess noise to maximum permissible limits set by the standard.

The acoustic effects such as echo, resonance, interference and distraction, association with sound wave propagation, should also be taken into account. Installing a soundproof window, reduces 75-95% of noise (Luster, 2002:137). The right choice of material for soundproofing can limit the noise in workplace to a tolerable level. In Nigerian market, there are various insulators, like acoustic foams for soundproofing and drapes specially designed to absorb sound waves. The entire process of soundproofing a room consist of several specific activities such as soundproofing the walls, the ceiling, the floor and even the window. Managing noise in the workplace through strategizing with these modern techniques has contributed
positively in enhancing the health and well-being of workers which invariably increase productivity and the reduction of absenteeism.

4. DISCUSSIONS

Measurement of noise characteristics should be performed in accordance with the established methods. Measurements are used in noise control to compare the actual (apparent) noise levels at workplaces in industrial premises to those established by the standard, (Hompland, 2005:163). Usually measured and calculated are the following quantities: the mean octave (band) sound pressure level $L$, in decibels, and mean loudness in db (A), the equivalent (in energy) sound loudness in db (A), and the mean equivalent loudness level in db (A) for non-stationary noises. Noise levels are measured at permanent workplaces. If the workplace is the work zone, measurements are made in at least three points of the work zone (Polter, 2003:127).

4.1 SOME PRACTICAL APPLICATIONS OF NOISE CONTROL PRINCIPLES

Noise control and the assessment of its effectiveness should be started at the stage of design or re-shaping of plants. When planning an area for an industrial development special attention should be paid to a rational physical positioning of separate buildings and design of workrooms within the buildings. Manufacturing processes that are likely to produce much noise, more than 90 db, must be located in separate buildings or otherwise isolated from the rest of industrial area (Olusanya, 2007: 128). One of the resources to achieve this end is the provision of acoustic gaps or movement arrestors along the perimeter of the foundation, filled with an insulating material. The other one may include free zones established between the “noise-making” departments or workshops. These free zones can be afforested to increase the effect of isolation and complement the environment. A “green belt” about 50 m wide can considerably reduce the noise level as foliage is a good sound absorber.

When planning for production areas and departments inside buildings it is desirable to group the machine-tools and equipment by their noisiness and assign to them separate premises or area section protected by a specialized sound-proof enclosure. Industrial premises with “noisy” processes should preferably be located on the windward side of the area (Reese, 2001:89).

The production areas with relatively calm processes or noiseless operations can be effectively protected from the external noise (from noisy work areas) through adequate sound-proofing of the walls and floors and other structural elements. In planning the sound proofing measures, one should take into account the character of the dissipation of an emission (sound, in our case), some part of which, or of the energy associated with it, on striking a surface (wall, ceiling, etc.) is reflected, some absorbed, and only a small part of it is able to penetrate through it.

Manufacturing undertakings employ all sorts of pumping and ventilation units (fans) which are interconnected by complicated systems of pipelines or air ducts that usually pass through workrooms and production grounds. When in action, such installations produce a lot of noise. To reduce noise from electric motors, pumps and fans, insulating pads are installed on separate basements with sound (vibration) or supports between them and their basements. Elastic inserts are used to couple pipes to pumps and air ducts to fans to reduce both vibration and noise resulting from it. Elastic pads, inserts or isolators are also used for noise reduction at points where pipelines and air ducts pass through the walls of the structures. Of all the measures of noise control the elimination of noise at the source, that is, directly in the apparatus machine or mechanism, is most effective (Polter, 2003:187).
Replacement of spur and of noise at the source can be achieved through: substitution of non-per-chain pinions with helical and chevron (hearing bone) gears; substitution of plastic and other “mute” materials for metal. The combination of metal parts with those of plastic, e.g. steel gears with kapron of fibre-base laminate pinions, etc. Other modern techniques include the use of lubricant baths for meshed gears, and forced-feed lubrication for articulated joints to minimize wear and noise caused by friction; use of lining, and elastic inserts in the joints to minimize or avoid transfer of vibration from one part of apparatus to another; reduction of the intensity of noise-making vibration of surfaces (jackets, casings, lid-covers, etc.) through stiff fastening or coating with sound-absorbing materials; use of rubber lining for inserts of metal containers and crates intended for the collection, handling or storage of work pieces.

Timely inspections and preventive servicing of equipment and machine-tools are exclusively important to avoid loose fastening and mismatch, and ensure accurate adjustment of the adjacent parts of equipment.

Sound-absorbing and soundproof finishing of room surfaces should be provided to place impermeable obstacles in the way of the propagation of sound waves. Noise silencers and sound absorbers must be installed as specified by the standard to suppress aerodynamic noises. Sound-proofing include the construction of barrier structures, such as walls or partitions, to safeguard the workers from external noise.

Sound-proofing utilizes the principle of reflection of sound, the greater part of the sound energy incident on a surface is reflected and only its smallest part (1/1,000, and less) penetrates through it. Ideally, a sound proof structure should not let noise into enclosure it safeguards. Sound energy penetrates through obstacles using their own vibrations. In other words, the obstacle itself becomes the source of noise and radiates sound energy into the room it is supposed to protect. The knowledge of the character of noise at the source is very important in sound-proofing. When constructing sound-proof structures it is essential not to forget that the external noise readily enters through any available opening or slot in the construction structure (Vassie and Lucas, 2001:479-490). This significantly reduces the sound-proofing effect of the structure. For example, external noise is easily heard through an open window or door. Naturally, making the wall thicker in this case would not be effective as the greater part of the external sound energy would penetrate through the window and only its minor part, through the wall. Consequently, air tightness of the construction is an essential condition for adequate sound-proofing. All the openings, uptight closures in the walls should be properly sealed over the entire area and depth; doors and windows should be properly fit to match the perimeter, and the window frame grooves receiving glass, adequately putted. All these measures are essential for the isolation of rooms with noise-making processes or operations, and for the provision of sound-proof observation and operation cabins for the personnel operating such equipment (Smallman and John 2001:25-29).

Sound absorption is the process by which sound energy is diminished in passing through a medium or striking a surface. It utilizes the principle of absorption of sound energy incident on an obstacle in the way of its propagation. The more sounds (emissions) are absorbed, the less are reflected and this leads to the reduction of the total noise level within an enclosure.

Most of the construction materials (concrete, brick, glass blocks, etc.) absorb less than 2% of the sound energy incident on their surfaces reflecting the rest 98% back to the room. Note that the level of noise produced by a source located in the room is by 5 to 15 db higher in loudness than that produced by the same source in the open (Hompland, 2005:87).

The application of the sound-absorbing materials with high coefficient of sound absorption for walls and ceilings permits the reflected noise to be diminished thereby reducing the total noise level in the workroom. Another benefit from sound absorption is the possibility of easy aural checking on the operation of the machinery because where a direct sound prevails noise from every apparatus or lathe installed in the enclosure can be easily detected by the ear.
Ceilings and the upper portions of the walls 1.5-2.0 m above the floor level should be logged with sound-absorbing material. The good effect of this measure is achieved when not less than 60% of the total area of the walls and ceiling in the room are lagged (Serxner and Gold, 2002:25-29). Sound absorbing lagging may also help to reduce noise levels by 6-8 db which corresponds to 1.5-1.8 times reduction of noise loudness. Where sound absorbing lagging of the interior surfaces is impossible or impracticable for technical reasons (equipment installations or piping), functional sound absorbers can suitably be used (Peterson, 2004:167). They are usually made in the form of thin shells of acoustic absorbing materials and suspended on wires. They are high efficiency absorbers and are often used in locations and work premises.

If properly selected and used, (Olusanya, 2007:87) posit that personal protective equipment and devices, such as sound-proof headsets (helmets), earmuffs, earplugs and noise stoppers can afford effective protection against noise disturbances and prevent various functional disorders. To the extent that accidents and occupational loss of hearing may result from exposure to excessive noise, these devices are a preventive measure and can be used in addition to the principal noise control measures when the former for some reason or the other prove ineffective.

Ear defenders are the simplest, cheapest and convenient devices used to reduce the harmful effect of noise. They are conically shaped plugs of various materials for insertion into the ear to reduce the perception of noise, particularly impulse noise. They can be soft or rigid. Rigid plugs are made of rubber or plastic materials while soft plugs are of cotton cloth or of very fine glass cloth impregnated with oil or a waxy mastic. Plugs do not prevent the wearer from wearing headpieces or goggles. However, during long use, ear defenders may cause discomfort and irritation in the ear, particularly at elevated temperatures. Application of multi-use ear defenders requires special medical supervision.

Earmuffs are large pads of rubber or similar material attached to a hand or strap and worn about the head for reducing the effect of noise on factory workers (during impact riveting, straightening, chopping and the like operations). The device is light, convenient to wear and effective against noise of high frequency which is exclusively harmful to the human ear and the body as a whole. Head-piece or helmet is an effective device against the effect of noise levels exceeding 120 db where the above protective devices are ineffective. High level of noise affects the skull causing the bones to vibrate (Polter, 2001:189). Such vibration he asserts adversely affects the auricular nerves and the brain function. Helmets provide adequate protection of the skull, particularly its paratideic region. Exposure of workers to industrial noise has been addressed since the 1930s. Changes include redesign of industrial equipment, shock mounting assemblies and physical barriers in the workplace.

The Nigerian Government views noise as a “nuisance” rather than an environmental problem, hence the enactment of factory laws and safety Decree No.16 1974. While in the United States of America, Canada and European Union there are national provincial, or state laws that protect against noise (Mossink, 2002:178). Noise laws and ordinances vary widely among municipalities and may contain a general prohibition against making noise that is a “nuisance”, or it may set out specific guidelines for the level of noise allowed at certain times of the day and for certain activities. Hence the new measures adopted by the government of Nigeria through factory laws to ensure that noise pollution is regulated in the interest of the public health in the workplace. Individuals can take many steps to protect themselves from the harmful effect of noise pollution. There are various strategies for combating noise in the workplace environment.

In recent times, the Environmental Protection Agency (EPA) revised its regulation for most hearing protection devices that are sold wholly or in part on the basis of their effectiveness to reduce unwanted noise in the workplace.
Polter, (2001:57) posits that an effective way to manage noise would be to wear ear protection device while working in a noisy condition. Vehicles and machines need to be maintained properly and checked from time to time. Lack of maintenance will not only increase noise levels, but also decrease the efficiency of these machines. The result of active noise control is a sound wave that is barely audible.

5. CONCLUSION

While this study provided seemingly conclusive evidence that noise can indeed have a detrimental impact on the workplace environment. Suggestions for eliminating or minimizing the impact of noise on workplace environment which was largely absent in earlier research, became more prevalent with the transition into the twenty first century with the increasing awareness of the problem. Each sound by itself is totally creating a different environment and virtually paralyzes policy makers seeking to settle the issue. The decision is not easy for we have structured our society around noise-producing progress, and in order to deal in reality we must acknowledge and accept a certain level of noise.

It can be handled well but when it is a dynamic user, noise control becomes a challenge. Repetitive sounds are easier to handle than continuous sounds. Earplugs and muffs are worn at working place to control workplace noise. When there is a lot of noise in the environment, it constitutes what is known as noise pollution.

While the management of noise requires good knowledge of its physical nature, properties and basic laws of its propagation. The technical progress in all branches of industry and workplace environment brings about the development and wide application of new equipment, machine tools and related facilities. This lends credence to the assertion that noise control and the assessment of its effectiveness should be started at the stage of design or re-shaping of plants.

6. THE WAY FORWARD

It is therefore recommended that trees should be grown on the premises of the workplace, which act as absorbents of noise. The trees grown on the premises of ANAMCO motors’ an automobile company based in Enugu State of Nigeria is a perfect example of how to reduce noise pollution in the workplace environment. Regular servicing of machineries and equipment could help in reducing the intensity of sound produced by them. Lubricating the machines used will be helpful in their smooth functioning. With increasing population, industrialization and urbanization, concerns over noise pollution have increased. The U.S. Environmental Protection Agency has set 55 decibels as the safe noise levels, and it takes several measures to maintain this level. Noise exposure time and the power level of noise are the important parameters that determine the damage to human ears. So, estimating the noise level is important to prevent high level intensity of noise, damaging our ear drums.

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