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Identification of Ways to Reduce Noise Pollution in Aircraft Hangars

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Abstract: The noise pollution produced by various aircraft systems, including hydraulic, pneumatic, electrical systems and auxiliary aircraft equipment inside the aircraft hangars, generally cause hearing impairment and mental disorder of shift and office personnel. Identifying hangar noise pollutants can lead to find solutions and methods to deal with the contaminants in the aviation industry. In the first phase of the research, the sound study in each specified region of the hangar, the required measurements and frequency analysis are done to determine the type of sound control appropriate for the hangar. Measurements in this study were conducted in accordance with standards, and the results of the measurements and equilibrium calculations after recording were compared with the permissible exposure limits in accordance with the Occupational Exposure Limit values. The results show that the highest sound pressure level corresponds to sheet metal activities (128 dBC) and thereafter respectively, pneumatic systems (112 dBC), hydraulic pumps (104 dBC) and electrical systems (86 dBA), and found that noise pollution of the hangar during the specified time for shift and office personnel is higher than the permissible limits, and this exposure is harmful to the physical and mental health of the staff. In the second phase of the research, by the results of statistical analysis of the questionnaires, there was a significant relationship between the result of estimating noise intensity and the extent of its annoyance by shift and office personnel, which most people in the hangar believe that this level of noise pollution is very annoying.

Keywords: Noise Pollution, Aircraft Hangar, Hearing Impairment, Disturbance Disorders, Events

1- Introduction

Aircraft noise has adverse effects on human health. The number of people with hearing loss due to this condition is so high and it can be considered as one of the important causes of this disease. The level of exposure of people and personnel to future airport noise and adjoining buildings is increasing as the population grows and airports expand, requiring more attention to the issue of noise pollution and that more acoustic coverings should be considered for exposed buildings in the context of noise prevention measures (1). The most influential people in airport noise are those who live in the vicinity of the airport or those who work in the air or ground section of an airport, so that regulations and programs are implemented in countries to reduce the effects of this pollution at the airports. The high intensity of aircraft noise that occurs naturally around large airports is known as increasing of hypertension as well as hearing loss. Noise in the industries also plays major role in causing health effect to the worker that working in the industries on different process. The industrial noise come under occupational health hazards, and continuous long term exposure of noise leads to the increase systolic blood pressure, stress and hearing impairment (2).

1.1. Necessity of research

Noise pollution caused by various aircraft systems, including hydraulic, pneumatic, electrical and aircraft accessories inside the hangars of Iran airports, as well as hangar structural equipment and systems, generally cause hearing impairment and disturbances of mentally operational of personnel inside the hangar and can provide for the preparation of events. People are always exposed to environmental pollution such as noise pollution and air pollution caused by aircraft activity at the airport. The results of the study show that among 35 ground surveyed employees of Mehrabad Airport, 18 persons (51.4%) have hearing loss. The results showed a direct relationship between non-use of hearing aids and hearing loss (3).

1.2. Research Objectives

This study will identify the main sources of hangar noise pollution and find strategies and ways to reduce their impact. The particular importance in this study is the detection and addressing of points and cases of noise pollution in aircraft hangars in airfield of Iran that have not been assessed so far, and this research can identify key factors and sources of the contaminants, and the amount of ambient noise at various points in the hangars, adjacent rooms and offices, will lead to find appropriate solutions to control and reduce noise pollution.

This is a hazard to the health of employees, especially those who are exposed to high noise from aircraft due to the type of tasks they perform on a daily basis. Therefore, strict precautionary requirements such as the use of acoustic and anti-noise protection devices or shortening the service life of such personnel are required (4). CAA "Recent Findings" (2016), expresses the researches and investigations into the noise pollution caused by aircraft and airport activities, and the facilities of these centers, as well as the consequences and effects of noise pollution on people from different points of view, including physical injuries to hearing and cardiovascular injuries as well as effects (5). In general, the sources of sound production in hangar are divided into three groups:

- Hangar Construction Equipment
- Aircraft Systems
- Aircraft Auxiliary Equipment

Short-term and long-term noise pollution creates irreparable effects for residents in the vicinity of the noise source. Based on the results in the study area, sleep disturbances, nervous states, mental illness, stress and speech interference are prioritized in terms of aircraft noise impact (6).

By comparing different aspects of people's lives near the airport and exposed to aircraft noise, concluded that the personnel had lower quality of physical and mental health than those who were not exposed to aircraft noise (7).

2- Materials and methods

The SPL (Sound Pressure Level) index was used in the study of aircraft hangar environments in order to determine the level of noise emission of resources, environmental and personnel exposure assessment. This measurement was carried out in six hangar situations where the sound emission balance of each condition was recorded in terms of duration and sound sources. Each measurement was performed with the acoustic meter for at least one minute at 2-hour intervals on grid A and C.

A low-frequency grid A is used to check the noise in a low-frequency hangar environment, and in the situation with the aircraft deployed, in order to determine how the personnel are exposed. Sound frequency analysis is performed on the C network which corresponds to the sensory perception of the ear at levels above 85 dB.

2.1. Research Environment

An overview of the main hangar area, offices and store rooms graphic map accompany with an Airbus family wide- body aircraft including the main sound sources while operating the aircraft pneumatic, hydraulic and electrical systems such as air conditioning units, cabin air pressure regulators, outlet valves and hydraulic pumps, which have the highest operating time and noise generation with the personnel positioning, besides two main hangar sound sources including air conditioning units and ventilators. Hangar area is divided into 42 zones to measure the environmental sound level. Because the sound propagation in different directions around a source is not the same, and personnel relocate around the aircraft, therefore, cannot rely solely on the measurement result at a station to express the sound pressure level of a source. To do this, the sound pressure level is measured at several points around the source usually personnel stopping points. (Figure 1)

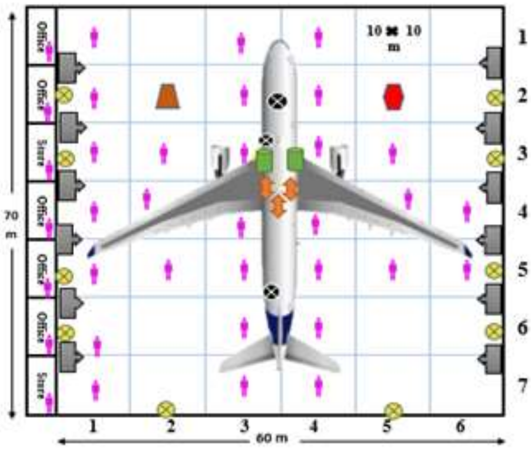

Fig 1- Sound Sources

The noisy sources description is as follows: (Table 1)

Table 1- Noisy Sources

Noisy Sources	Number	Symbol
Hangar Air Conditioning Units	12	
Hangar Ventilators	10	
Hydraulic Pumps	3	
Pack System Units	2	
Air Outlet Valves	3	
Air Service Unit (ASU)	1	
Hyraulic Ground Power Unit (HGPU)	1	

2.2. Findings

The measurements and applications according to ISO 3746 required in this study are as follows: Specified points around the source and the sound pressure level is measured, and by using the relation below (Equation 1), the sound pressure level average is calculated.

$$\overline{LP_T}\ (dB) = 10 \log [1/n\ \Sigma 10^{LPi/10}]$$

Equation 1

2.2.1. Situation A: Hangar without Aircraft

Air conditioners and ventilators of this hangar are constantly and uniformly operating about 11 hours in a shift-work day. The highest level was measured in the main hangar space of 64 dB (A), and in the offices and storage rooms of 46 dB (A), and the 11-hour and 8-hour equivalent levels were obtained. (Figure 2)

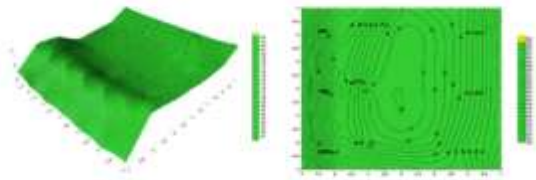

Fig 2- Situation "A" 3D & Contour Isosonic

2.2.2. Situation B: Hangar with Positioned and Powered Aircraft

In this case, in addition to hangar air conditioning systems and ventilators, aircraft permanent air conditioning systems work uniformly. The highest level was measured in the main hangar space of 86 dB(C), and in the offices and storage rooms 61dB(C), and thus the 11-hour and 8-hour levels were obtained. (Figure 3)

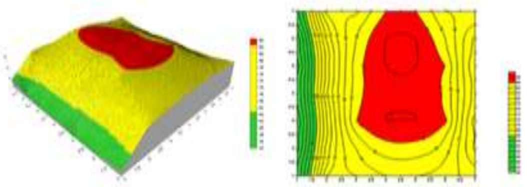

Fig 3- Situation "B" 3D & Contour Isosonic

2.2.3. Situation C: Aircraft Pneumatic Systems Operating

In this case, in addition to the systems that are operative in the first and second situation, aircraft pneumatic systems and equipment such as PACKs and Air Service Unit (ASU) work uniformly. The highest level was measured in the main hangar space of 112 dB(C), and in the offices and storage rooms 94 dB(C), and thus the 11-hour and 8-hour levels were obtained. (Figure 4)

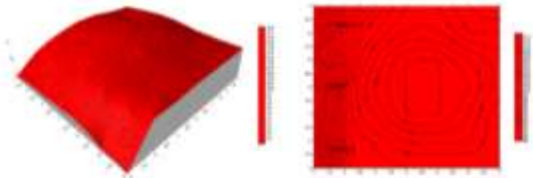

Fig 4- Situation "C" 3D & Contour Isosonic

2.2.4. Situation D: Aircraft Hydraulic Systems Operating

In this case, in addition to the systems that are operative in the first and second situation, aircraft hydraulic pumps and Hydraulic Ground Power Unit (HGPU) work for an indefinite period of time. The highest level was measured in the main hangar space of 104 dB(C), and in the offices and storage rooms 84 dB(C), and thus the 11-hour and 8-hour levels were obtained. (Figure 5)

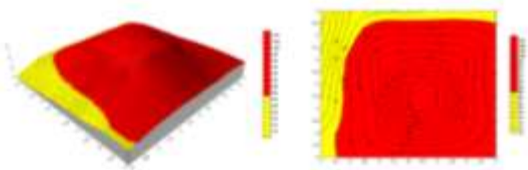

Fig 5- Situation "D" 3D & Contour Isosonic

2.2.5. Situation E: Simultaneous Operation of Aircraft Systems

Since the personnel is exposed to different levels during shift-work day, in assessing noise to evaluate personnel exposure, calculations are made based on exposure to different levels at different times. In this method, each exposure level is first recorded, along with the corresponding exposure time measured, then using the following equation (Equation 2), the equivalent exposure level is calculated for a time period. This calculated balance is the time average of balances that can be calculated based on the sum of exposure times or on a given time period.

The environmental noise level is done by a direct method, using the integrated sound level meter with Leq measurement facilities. Event measurement is performed every 5 second for 10 minutes. The interval time is set for 1 hour (8).

$$Leq\ (dB) = 10 \log [1/T\ \Sigma\ ti\ 10^{LP/10}]$$

Equation 2

Given the above situations, in one measurement during a shift-work day, two hours with 97 dB, one hour with 112 dB, two hours with 104 dB, four hours with 86 dB and two hours of rest were recorded for the ambient pressure level of 61 dB and an equivalent level of 11-hours was obtained for the main hangar space of 113.2 dB and the equivalent of an 8 -hour exposure will be equal to 114.5 dB.

$$Leq\ (dB) = 10 \log [1/11 \times (2\times10^{9.7}) + (1\times10^{11.2}) + (2\times10^{10.4}) + (4\times10^{8.6}) + (2\times10^{6.1})] = 113.2\ dB$$

$$Leq\ (dB) = 10 \log [11/8 \times 10^{11.32}] = 114.5\ dB$$

Also measured during shifts for offices space, two hours at 80 dB, one hour at 94 dB, two hours at 98 dB, four hours at 70 dB, and two hours at rest with 61 dB. The equivalent of 11-hours for office and store spaces was obtained 101.8 dB, and the equivalent of an 8-hour exposure will be equal to 103.1 dB.

$$Leq\ (dB) = 10 \log [1/11 \times (2\times10^{8})+(1\times10^{9.4})+(2\times10^{9.8})+(4\times10^{7})+(2\times10^{6.1})] = 101.8\ dB$$

$$Leq\ (dB) = 10 \log [11/8 \times 10^{10.18}] = 103.1\ dB$$

2.2.6. Situation F: Sheet Metal Activities

A study by a Swedish airline in 2011 examined the hearing loss of aircraft technicians and mechanics, and the results showed that exposure was too high in the hangar (91 dBA), and during sheet metal activity, even it has been recorded 119 dBA inside the earmuff (9).

This activity is kind of an impact sound that is done in short but frequent times and it may take up to several hours during a shift-work day. Due to the reflection problem in this case, each measurement time in each area is considered to be more than 5 seconds in the 2-hour period, due to the difference in the initial seconds. The highest level was measured in the main hangar space of 128 dB(C), and in the offices and storage rooms 100 dB(C), and thus the 11-hour and 8-hour levels were obtained. (Figure 6)

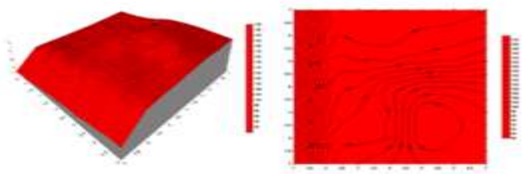

Fig 6- Situation “F” 3D & Contour Isosonic

2.3. Questionnaire

In the second phase of the study and after determining the noise exposure level of the hangar staff, the demographic information questionnaire and the ambient noise abnormality of the hangar offices and warehouses were distributed and completed in both shift and administrative personnel. Content validity of the annoyance questionnaire was obtained by the opinions of relevant experts. Preliminary test was performed to determine the reliability of the questionnaire. This questionnaire consisted of three subscales of scoring the noise intensity of the hangar ambient, scoring the annoying noise of the hangar ambient, and determining the decrease of concentration and mental control that staff experienced during the day. In the first and second subscales, questions were raised about noise from aircraft and hangar systems and equipment, as well as a questionnaire about the reduction in concentration and mental control that personnel experience in the hangar environment. In the third sub-test that examined the amount of noise received, both shift and hangar personnel were asked to rate the sound of their surroundings from 0 to 10, and they were also asked to rate the annoyance of the ambient noise ranged from 0 to 100.

This research uses descriptive statistics techniques and Pearson's chi-squared and T tests in SPSS software to analyze research data.

2.3.1. Research Descriptive Statistics

The aircraft hangar staff are consisted of two groups of shift and administrative personnel and both groups work differently as working hours. The shift group includes technicians, engineers, inspectors, assisting technicians, warehouse personnel, control and planning personnel, and the administrative group includes office workers that are a total of 168 people aged 20-60 working in the hangar. Except for office staff who work in the hangar 8 hours a day, shift workers are provided with an 11-hour presence, excluding breaks.

2.3.2. Research Inferential Statistics

In inferential statistics analyzes, Pearson's chi-squared and T tests used for data analysis and validity of questions. In this test, the null and substitute assumptions are as follows:

- H_0: The average number of opinions of all those working in the hangar is 8 out of 10.
- H_1: The average number of opinions of all those working in the hangar is not 8 out of 10.
- In all questions, the significance level is less than 0.05, so the null hypothesis is rejected.

Table 2- Abundance of Personnel

Department	Abundance of personnel	Work Hours/ per Day
Technicians/ Engineers	106	11
Inspectors	8	11
Stores Personnel	6	11
Control/ Planning Personnel	12	11
Office Employees	29	8
Workers	5	11
Total	168	-

3- Results

The structure of old aircraft hangars in Iran is generally built with steel structures and depending on the type of structure are affected by maximum factors such as indoor and outdoor temperature of the hangar, which require ventilation systems to provide adequate temperature inside with the high efficiency, and this increases the power of acoustics in using these equipment. The country's Occupational Health Technical Committee, which is under the watch of the Ministry of Health, has released a list called Occupational Exposure Limit (OEL), which is the national criterion of exposure limits. According to the categorization of audio sources in different hangar and aircraft situations, the topic has been discussed in several topics.(Table 3)

Table 3- Results

Situation	Hangar		Equivalent to 8 Hours	Offices & Stores		Equivalent to 8 Hours	8 Hour Exposure Limit (dB)	
	Equivalent to 2 Hours (dB)	Equivalent to 11 Hours (dB)	Hangar (dB)	Equivalent to 2 Hours (dB)	Equivalent to 11 Hours (dB)	Offices & Stores (dB)	Limit of care in OEL (dB)	Exposure Limit of OEL (dB)
A	64	57.6	58.9	46	38.6	39.9	82	85
B	86	78.6	79.9	61	53.6	54.9	82	85
C	112	104.6	105.9	94	86.6	87.9	82	85
D	104	96.6	76.6	84	97.6	77.9	82	85
E	120.6	113.2	114.5	109.2	101.8	103.1	82	85
F	128	120.6	121.9	100	92.6	93.9	82	85

3.1. Frequency Analysis

Although physical or logarithmic quantification is used to express or measure sound quantities, the listener's perception of certain quantities of sound is not the same at different frequencies, and therefore, in addition to the quantity or amount of sound, how well a person hearing is understood at the relevant frequency is important. In fact, the same balances at measuring the acoustic frequencies of each source, frequency analysis in one octave and one third octave band was performed to evaluate the sound. The analysis of the frequency, along with the overall measurement of sound in the C frequency network, was performed and recorded. (Table 4)

Table 4- Dominant Central Frequencies of Aircraft Devices and Systems

One Octave (Hz)	125	250	500	1000	2000	4000	8000	16000
One Third Octave (Hz)	100, 125, 160	200, 250, 315	400, 500, 630	800, 1000, 1250	1600, 2000, 2500	3150, 4000, 5000	6300, 8000, 10000	12500, 16000, 20000
Air Outlet Valves (dB)	70	78	79	81	86	72	64	55
ASC & Packs (dB)	85	90.5	103	112	102	88	72	67
HGPU (dB)	77	84	92	89	90	97	91	72
Hydraulic Pumps (dB)	76	83	102	86.5	91	104	96	84.5
Sheet Metal (dB)	69	71.5	80	98	125	116	128	120

3.2. Questionnaire Analysis Results

The results showed that 46.4% of the sample were between 20-30 years old, 30.4% 30-40 years old, 14.9% 40-50 years old and 8.3% more than 50 years old. The results also show that 57.1% of the sample have less than 10 years' experience, 25.6% have 10-20 years, 12.5% have 20-30 years and 4.8% have more than 30 years' experience. According to the questionnaire null and substitute assumption results, the mean of staff's opinions with number 8 out of 10 was significantly different. Referring to the results of the statistical analysis of the questionnaires, there was a significant relationship between the result of estimating the noise intensity of the hangar environment and the amount of disturbance by shift and office personnel answers.

4- Discussion

According to the measurements and values obtained in the previous chapter of this study, and comparing these values with Occupational Exposure Limit (OEL), the noise pollution of the hangar environment was higher than the permissible time limit for shift and office personnel, and the exposure is harmful to the physical and mental health of the staff. Hanger auxiliary equipment, including air conditioning units and ventilators are long lasting and have a high sound intensity, and their accessories produce more noise over time due to depreciation of parts. Another factor that exacerbates the effects of noise pollution in the hangar is the reflection phenomenon. Maximum sound level of 64 dB(A) obtained in the main hangar space when the aircraft was not deployed and the maximum level of 46 dB (A) in offices and rest rooms was set to an exposure limit within an 11-hour shift, according to the OEL. The permanent air-conditioning system of the aircraft, from the moment the aircraft electric grid was established, was uniformly active during an 11-hour shift, and according to measurements, a maximum level of 86 dB (A) was recorded, indicating the specified areas according to the OEL, the limit is exceeded, and in offices and warehouses, measurements were 61 dB (A), which is within the exposure limit. The SPL of aircraft pneumatic auxiliary systems and equipment were calculated and found very high in the hangar, and the equivalent sound levels of 112 dB (C) were measured, and according to the OEL, the exposure level of main hangar area, the offices and warehouses personnel for more than 2 hours is considered to be exceeded. During the time aircraft hydraulic systems and accessories are switched on and used for specified periods with the variable voices, intermittently and alternately, the equivalent sound level of 97 dB (C) was measured in main hangar area, and in the rooms and offices, the maximum level of 80 dB (C) is recorded. So the personnel's exposure is considered to be excessive for more than 2 hours, which is set by the exposure limit according to the OEL. At the time of sheet metal activity in the hangar, the SPL of 128 dB (C) was measured for the equivalent of 2 hours in main hangar area, and the equivalent of 2 hours recorded 100 dB (C) as well as in the rooms and offices. Sheet metal activity has been set to exceed the permitted exposure limit in personnel stop and traffic areas even once, and is considered to be excessive according to the OEL. Sheet metal activities that are intermittent during shifts and lasting up to several hours are even more than permitted limit for offices and warehouses. Results and findings of personnel exposure measurements in the hangar, around the plane, offices and stores compared to OEL values. In summary, sheet metal activities are the sources of anomalous sounds that have the highest sound level (128 dB), and then, respectively, are the pneumatic systems (112 dB), the hydraulic systems (104 dB), and the aircraft electrical systems (86 dB). According to frequency results, as was done to determine the appropriate sound control shields in the hangar, it was found that the earmuffs and earplugs used in this hangar are not suitable for high frequency audio sources. Referring to the results of the statistical analysis of the questionnaires, there was a significant relationship between the result of estimating the noise intensity of the hangar environment and the amount of disturbance by shift and office personnel answers. So that shift personnel evaluated that the nuisance of the main hangar space is more than the office personnel. While hearing impairments are a major concern with noise exposure, other physical and mental effects should not be neglected. The more complex the task, the perturbation and concentration of personnel increases while working in the hangar, relative to the disturbing factor such as noise. This leads to an increase in the number of errors, accident preparations, and a slower process. According to the questionnaire null and substitute assumption results, the mean of staff's opinions with number 8 out of 10 was significantly different.

5- Conclusion

The results showed that noise pollution from different sources in this hangar was high and likewise, the impacts of this level of noise pollution on the health of personnel employed in this hangar can be affected. Comparing these values with the Exposure Limit Table, the noise pollution of this hangar was higher than the permitted time for shift and office personnel, which is harmful to the physical and mental health of the personnel. Hanger equipment, including air conditioning units and ventilators, are highly durable and have a high volume of sound, and their accessories produce more noise over time. Another factor that exacerbates the effects of noise pollution in the hangar is the reflection phenomenon. Frequency analysis in one octave and one third octave band was performed to evaluate the noise in the hangar environment. It was found that the ear protectors used in this hangar were not suitable for high-frequency sound sources.

Aircraft noise pollution and its impact on people's health and quality of life is a complex issue, requiring solutions beyond noise measurement, and management-level decisions and policy making that can bring greater safety to the aviation industry and noise pollution control, is even stronger than most research (10). According to the results of the statistical analysis of the questionnaires, there was a significant relationship between the outcome of the noise intensity estimation and the amount of disturbance by shift and office personnel, so that shift personnel rated the noise of the main hangar area more annoying than office personnel and it can be concluded that most people in the hangar believe that this level of noise pollution is very annoying.

5.1. Solutions and Principles of Sound Control in Hangar (According to ISO 11690)

Reducing noise pollution in hangar is to reduce its effects on hangar personnel and includes Management Control and Technical Control.

5.1.1. Hangar Management Control

Hangar Management Control takes precedence and control over its technical and engineering control.

Hangar management control can include:

Preventive care in the hangar such as medical, technical and personal protection management measures, shift staff training, reducing unnecessary exposure, selecting appropriate personnel for some noisy activities, rotating tasks and monitoring the health of employees, implementation of Hearing Conservation Program (HCP) included continuous measurement and evaluation of hangar personnel exposure, use of hearing protection equipment commensurate with the frequency range of the sound source in the hangar, adequate monitoring of exposed persons and audiometry testing when exposed to excessive noise.

Reducing exposure time in a way that if the person in the hangar has more than the permitted level of exposure, the exposure time should be reduced. Contractually, the exposure duration is cut by half for an increase of 3 or 5 dB. This is called the rule of 3 or 5 decibels. In Iran, according to the National Occupational Health Technical Committee, the sound pressure level allowed is 8 hours per day, 85 dB with the rule of 3 dB.

5.1.2. Hangar Technical Control

Hangar Technical Control method is divided into three parts:

1. Hangar-based control includes first in the hangar structure noisy sources, and second, sound emission path in hangar environment. Control in the sound source of structural hangar can start with the design of air conditioning units by utilizing of devices and units that have poorer sound sources or sound control devices that already be installed on the unit. The sound of working units can also be controlled by changes in their structure, modification of how the machine operates, troubleshooting, as well as discovering the causes of sound creation or amplification. Path control can start with sound absorption property in sound propagation, and insulation of environment to prevent sound passing. In table below, comparing of the two hangars at the equivalent of 8 hours, with the hangar number 2 in the offices and warehouses being sound isolation is presented. It is obvious that the value of exposures at the time of the various activities has been set to the equivalent of an 8-hour exposure by performing the

isolation technique in hangar No. 2 in the offices and warehouses. (Table 5)

Table 5- Comparison of two hangars with insulation

Situation / Hangar	A/C Air Condition OP. (dB)	A/C Hydraulic SYS. OP. (dB)	A/C Pneumatic SYS. OP. (dB)	Sheet Metal Activity (dB)
Hangar No. 1 Offices	58	79	92	94
Hangar No. 2 Offices	44.5	63	81	78.5

2. Acoustic-based control can be very effective in reducing noise pollution in the hangar. Reflective surfaces of hangar walls (five metal-sided) in the emission field can amplify the sound of sources. The rate of sound absorption in different materials is proprietary and is constant for any material. Each material has its own absorption coefficient in terms of the percentage of sound energy absorbed in the whole frequency band as well as in each frequency. Transmission loss at low frequencies is lower than at high frequencies and the low-frequency acoustic insulators perform poorly. Due to the high frequency of aircraft noise sources and equipment, the use of acoustic insulation can be very effective in reducing noise pollution in the hangar. Since environmental parameters such as temperature and humidity are effective in absorption and reproducibility of sound, so design and innovation in hangar equipment and type of absorbent insulation in hangar walls can reduce the rate of sound reproduction. In order to control and reduce the noise produced by high-pressure air outflow in some aircraft equipment and ventilation systems used in the hangar, it can be reduced by using mufflers and silencers.

3. Personal protection control is the last way to control the sound. In addition to quality and convenience, the device must be sufficiently adapted to the ambient noise conditions in terms of noise reduction and proportional to the sound frequency, as well as training to be provided to personnel within the hangar for optimal use. In order to select the appropriate ear protector, the noise level distribution characteristics of the ambient sound pressure must first be measured at different frequencies and standard earmuffs or earplugs are utilized appropriate to the desired frequency range.

5.2. Suggestions

a. Installation of sound dampers on noisy equipment: Materials used in enclosing acoustic sources can be iron sheets of different thicknesses, chipboard, rock wool, glass wool, polyurethane foam and punch sheets with considering the thermal output space of the units. Acoustic curtains are a combination of sound insulators and absorbers used to control the noise from a variety of industrial and environmental audio sources. Acoustic curtains have features such as good effectiveness, light weight, high durability and environmental resistance, variability in thickness with respect to sound, adaptability to acoustic conditions, easy installation, and a low cost for use in the insulation process.

b. Acoustic insulation of hangar walls, offices and warehouses: Construction of partition (sound insulation) between offices and main hangar with double glazed glass and laminated doors.

c. Wardrobe for the person or persons involved in a noisy area: Manufacture and design of an acoustic quadruped chamber for auxiliary aircraft equipment including the use for Air Service Unit (ASU) and Hydraulic Ground Power Unit (HGPU) as well as the installation of a special chamber for sheet metal activities.

d. Scheduled by the hangar control and planning department to perform pneumatic, hydraulic, and sheet metal activities to prevent their simultaneous execution, as well as to reduce their execution time and to plan some of these activities outside the hangar.

e. Reducing personnel exposure time with the audio sources by utilizing the rotating system for noisy activities, or reducing the time by changing the shift pattern of the hangar.

f. Continuous training and monitoring of the use of appropriate personal protective equipment with activity type in the hangar, taking into account the frequencies of audio sources, and comfortable and easy use of these equipment for exposed persons, and encouraging them to continue to use them during work.

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