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Agenda Item 16: Environmental Protection – General provisions, Aircraft Noise and Local Air Quality

ASSESSMENT OF NOISE POLLUTION IN AIRCRAFT HANGARS

(Presented by Iran (Islamic Republic of))

EXECUTIVE SUMMARY

The noise pollution produced by various aircraft operational 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. The sound study in each specified region of a typical (five metal-sided) 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.

Strategic Objectives:	This working paper relates to Strategic Objectives Environmental Protection and Safety.
Financial implications:	Not applicable

References:	[1] CAA (2016), Aircraft noise and health effects, recent findings, Civil Aviation Authority, Environmental Research and Consultancy Department, Policy Programs Team, Civil Aviation Authority, CAA House [2] Clark, C. (2015), Aircraft noise effects on health, Centre for Psychiatry [3] ISO (2019), International Organization for Standardization. Acoustics determination of occupational noise exposure and estimation of noise-induced hearing impairment: Geneva [4] Berry, B., Sanchez, D. (2014), The economic and social value of aircraft noise effects, 11th International Congress on Noise as a Public Health Problem (ICBEN), Nara, JAPAN [5] Smedje, G., Lundén, M. (2011), Hearing status among aircraft maintenance personnel in a commercial airline company, (13)54, 364-370 [6] Eibich, P., Kholodilin, K. (2015), Aircraft Noise in Berlin Affects Quality of Life Even Outside the Airport Grounds, Aircraft Noise and Quality of Life, 127-134

1. INTRODUCTION

1.1 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.

1.2 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.

1.3 Noise in the industries also plays a major role in causing health effects to the worker that works in the industries on different process. The industrial noise comes under occupational health hazards, and continuous long term exposure of noise leads to an increase in systolic blood pressure, stress and hearing impairment.

2. RESEARCH OBJECTIVES

2.1 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, 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.

3. MATERIALS AND METHODS

3.1 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 integrated sound level 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.

4. RESEARCH ENVIRONMENT

4.1 An overview of a typical (five metal-sided) hangar area, offices and store rooms with a typical 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.

5. MEASUREMENTS AND EXPOSURE ASSESSMENT

5.1 Situation A: Hangar without Aircraft:

5.1.2 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.

-Balance equivalent to 11 hours for the main space of the hangar:

$$Leq\ (dB) = 10 \log [1/T\ \Sigma\ ti\ 10^{LP/10}] = 10 \log (2/11 * 10^{6.4}) = 56.6\ dB$$

-Balance equivalent to 11 hours for offices and warehouses:

$$Leq\ (dB) = 10 \log [1/T\ \Sigma\ ti\ 10^{LP/10}] = 10 \log (2/11 * 10^{4.6}) = 38.6\ dB$$

-Balance equivalent to 8 hours for the main space of the hangar:

$$Leq\ (dB) = 10 \log [1/T\ \Sigma\ ti\ 10^{LP/10}] = 10 \log (2/8 * 10^{6.4}) = 57.9\ dB$$

-Balance equivalent to 8 hours for offices and warehouses:

$$Leq\ (dB) = 10 \log [1/T\ \Sigma\ ti\ 10^{LP/10}] = 10 \log (2/8 * 10^{4.6}) = 39.9\ dB$$

5.2 Situation B: Hangar with Powered Aircraft

5.2.1 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.

5.3 Situation C: Aircraft Pneumatic Systems Operating

5.3.1 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.

5.4 Situation D: Aircraft Hydraulic Systems Operating

5.4.1 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.

5.5 Situation E: Simultaneous Operation of Aircraft Systems

5.5.1 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.

$$\text{Leq (dB)} = 10 \log [1/11 \times (2\times10^{9.7}) + (1\times10^{11.2}) + (2\times10^{10.4}) + (4\times10^{8.6}) + (2\times10^{6.1})] = 113.2 \text{ dB}$$
$$\text{Leq (dB)} = 10 \log [11/8 \times 10^{11.32}] = 114.5 \text{ dB}$$

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.

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

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

5.6 Situation F: Sheet Metal Activities

5.6.1 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.

5.7 Frequency Analysis

5.7.1 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.

6. CONCLUSION

6.1 The results showed that noise pollution from different sources in the hangar was high and likewise, the impacts of this level of noise pollution on the health of personnel employed in the hangar can be affected. Comparing these values with the Exposure Limit Table, the noise pollution of the 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, various aircraft operational systems, including hydraulic, pneumatic, electrical systems, auxiliary aircraft equipment and sheet metal activities, are highly durable and have a high volume of sound, and 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 the 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.

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