Aircraft Noise Levels in Military Runway and The Impact of Personnel Hearing Resistance on Coping with Physiological Attacks

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Abstract— Along with the increasing frequency of air transportation in Indonesia, there is a level of noise which is a passive physiological attack in the form of a negative impact on hearing. This study focuses on reviewing aviation noise levels, as well as predicting the impact of personnel hearing resistance on coping with physiological attacks. The method used is observation. Noise level measurements are carried out at three airport runway points, namely flyover, lateral, and approach. Data processing is carried out in accordance with the Weighted Equivalent Continuous Perceived Noise Level (WECPNL) standard. The results obtained in the Flyover zone is 84.61 dBA, the lateral is 85.06 dBA, and the Approach zone is 84.97 dBA. The impact that occurs with exposure to noise is 84.61 dBA to 85.06 dBA, on the physiology of personnel, the risk is 1.4% to 4.9%. Prevention of physiological attacks against noise, which is recommended based on IATA (International Air Transportation Association) standards, with a noise level of 84.61 dBA to 85.06 dBA, personnel are recommended to use ear plugs and ear muffs for every work activity.

Keywords— Measurement, Noise, WECPNL, Physiological.

1. INTRODUCTION

Developments in the aviation industry sector have provided many benefits for human life. This development is evidenced by the two busiest airlines in Southeast Asia, namely Lion Air Group and Garuda Indonesia in 2018 beating Air Asia and also Singapore Airlines in Southeast Asia (Seasia, 2018). However, along with the progress of aviation transportation, there are problems caused, namely the noise generated during Take-Off and Landing of the aircraft. This development can actually have an unfavorable impact which can be categorized as a passive physiological attack for humans, especially airport runway personnel.

According to experts, noise is a sound that is unwanted by humans. Humans can only receive 85 dBA of noise with a period of 8 hours (Ministry of environment). According to international aviation standards, the noise level caused by aircraft engines during takeoff and landing is in the range of 90 dBA to 108 dBA for commercial airlines. This has exceeded human tolerance and will have an impact on physiological, especially hearing for personnel on duty at the airport.

Halim Perdanakusuma Airport itself has a flight intensity of around 7,400,000 times in 2018, which was named the 8th busiest airport in Indonesia in 2020 which is managed by the Indonesian Army. This study focuses on reviewing aviation noise levels, as well as predicting the impact of personnel hearing resistance on coping with physiological attacks.

2. METHODOLOGY

This study was designed using observation methods, and direct measurements at the landing and takeoff points of flights. The analysis obtained, derived from the calculation of WECPNL (Weighted Equivalent Continuous Perceived Noise Level) and risk prediction based on the book of the U.S Department of Health and Human Services (2002), to determine noise level of the generated from flight activities and predict the impact of hearing resistance on personnel.

2.1. Observation

According to Sugiyono (2018), observation is an activity of observing an

object. In the process of collecting data, observations were divided into participants and non-participants. In this study, researchers chose the type of observation with non-participant observation. Sugiyono (2018), explains that non-participant observation is a researcher's approach in observing activities in an environment. Observations in this study were carried out by observing and recording the busy activities of aircraft flights at the Halim Perdanakusuma airport location.

Observation were made by determining the measurement zone determined based on the International Civil Aviation Organization (ICAO) international noise measurement standard (2007), which was quoted and carried out at 3 measurement points:

1. Flyover reference point
2. Lateral full power point
3. Approach reference point, the description is as follows:

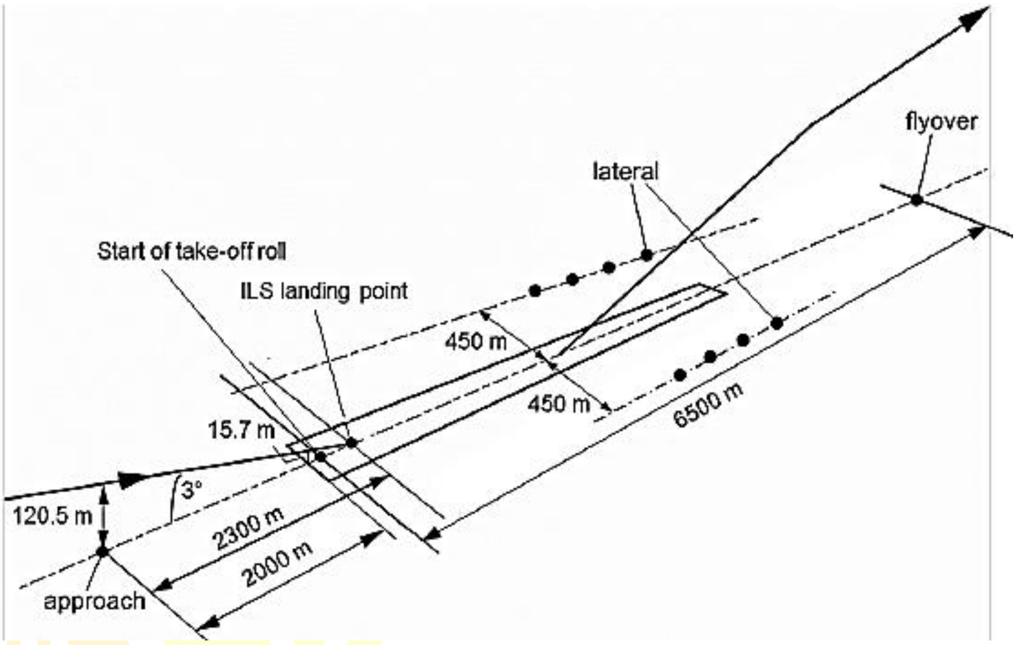

Figure 2.1: *Flyover, lateral and approach zone*
Source: ICAO.2007

The location of the zone at Halim Perdanakusuma Airport is as follows:

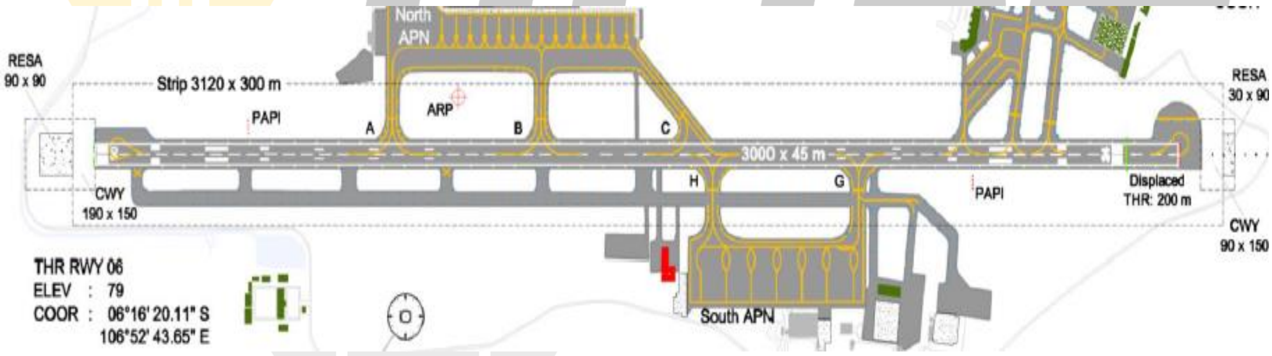

Figure 2.2: *Flyover, lateral, and approach zone in Halim Perdanakusuma Airport.*
Source: *Author.2020*

2.2 Measurement

Measurement of noise in this research activity, using a Sound Level Meter (SLM) with units of decibels (dB) weighting A. Data collection is carried out according to local flight times.

The measurement time was carried out during 24-hour activities which were divided into day and night activities.

Daytime activities for 16 hours at intervals of 06.00 – 22.00 local time, and night activities for 8 hours at intervals of 22.00 – 06.00 local time. The Measurement Schedule is adjusted to the existing flight schedule according to the ongoing flight activities.

The noise level measurement has a measuring distance of 50m from the runway. Determination of measurement points using the grid method, namely with regular points.

2.3 Data processing

The noise calculation method used in this study is the Weighted Equivalent Continuous Perceived Noise Level (WECPNL) method. According to Kem.MenHub No.13, 2010, this method is also based on the standards of the International Civil Aviation Organization (ICAO). The calculation to measure the average flight noise at each point is formulated in equation (1) as follows:

$$dB\,(A) = 10\,log\left[\frac{10^{\frac{L1}{10}} + 10^{\frac{L2}{10}} + 10^{\frac{L3}{10}} + \ldots + 10^{\frac{Ln}{10}}}{n}\right] \quad (1)$$

Where:

dB(A) : Average noise intensity.

L : Noise value at the time of aircraft movement.

n : Number of arrivals and departures of aircraft 24 hours.

Then to determine the flight frequency at the airport formulate equation (2) as follows:

$$\mathbf{N = N_2 + 3N_3 + 10\,(N_1 + N_4)} \quad (2)$$

From equations (1) and (2) we get the WECPNL calculation to determine the noise index:

$$\mathbf{WECPNL = dB\,(A) + 10\,log\,N - 27} \quad (3)$$

Where:

N: Number of arrivals and departures in 24 hours in different time weights.

dB (A): The average decibel value of the peak of the aircraft's busyness within 24hours

- N1: Number of arrivals and departures of aircraft from hours 00.00 – 07.00 WIB
- N2: Number of arrivals and departures of aircraft from hours 07.00 – 19.00 WIB
- N3: Number of arrivals and departures of aircraft from hours 19.00 – 22.00 WIB
- N4: Number of arrivals and departures of aircraft from hours 22.00 – 00.00 WIB

3. RESULT AND DISCUSSISONS

3.1 Noise level in 3 zone

Flight traffic data obtained based on field observations and measurements made at 3 measurement points: 1) Flyover reference point, 2) Roll away runway, namely lateral full power point 3) Approach reference point, focused on measuring flight landing and takeoff activities, as follows:

Flyover reference point

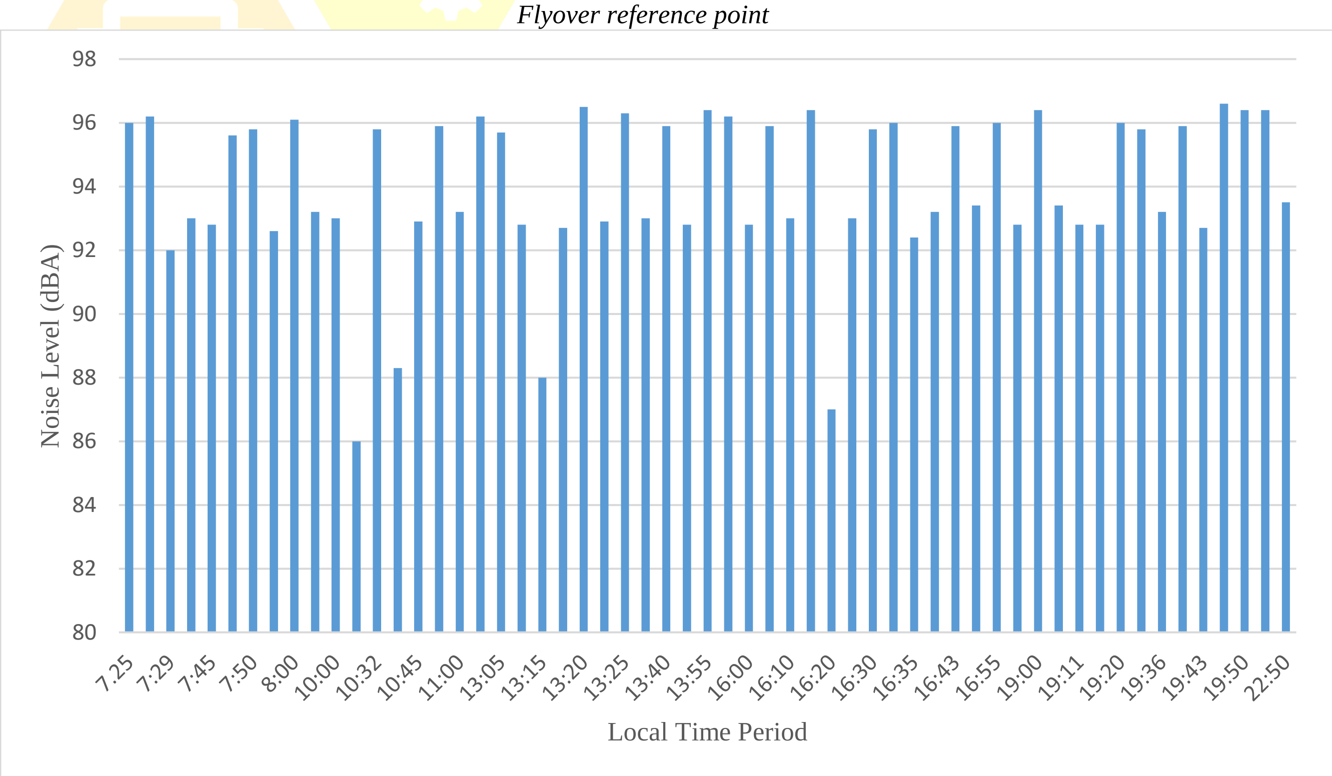

Figure 3.1: *Noise level in Flyover zone*

Source: *Author.2020*

Based on the diagram above, it is the result of measuring the noise level at the flyover reference point zone. The results obtained a sample of 59 flights ranging from 7.25 to 22.50 local time. It was found that the noise level ranged from 86 dBA to 96.6 dBA. The average noise level obtained is 91.94 dBA. Based on the results of observations made, variations in noise levels occur due to differences in measurement time, the type of aircraft engine used. The lowest noise level is 86 dBA, caused by the movement of the ATR-72,700 type aircraft, while the highest noise level is caused by the movement of the A320-214 type aircraft. At the measurement location, there is no interference by other noise sources. This is because the measurement location is above the flight area and is only 50m from the runway.

Lateral full power point

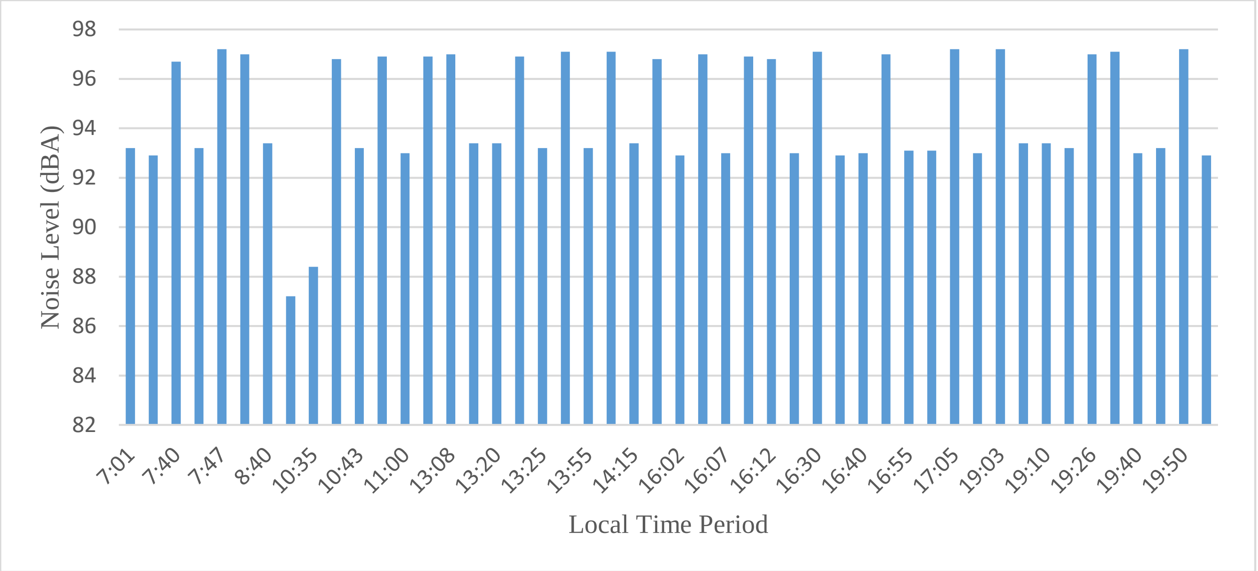

Figure 3.2: *Noise level in Lateral zone*
Source: *Author.2020*

The diagram above is the result of measuring the noise level in the lateral full power point zone. Measurements are made at a distance of 50 meters from the flight runway so that there is no other noise interference that interferes with measurement activities. The results obtained in the form of a sample of 50 flights ranging from 7.01 to 20.00 local time. It was found that the noise level ranged from 87.2 dBA which occurred at 8.40 to 10.35 local time. Meanwhile, the highest noise level data is 97.2 dBA which occurs in each measurement session in the morning, afternoon, and evening. The measurement results obtained an average of 92.33 dBA, or 0.39 dBA higher than the average noise level of the reference point flyover zone.

Approach refrence point

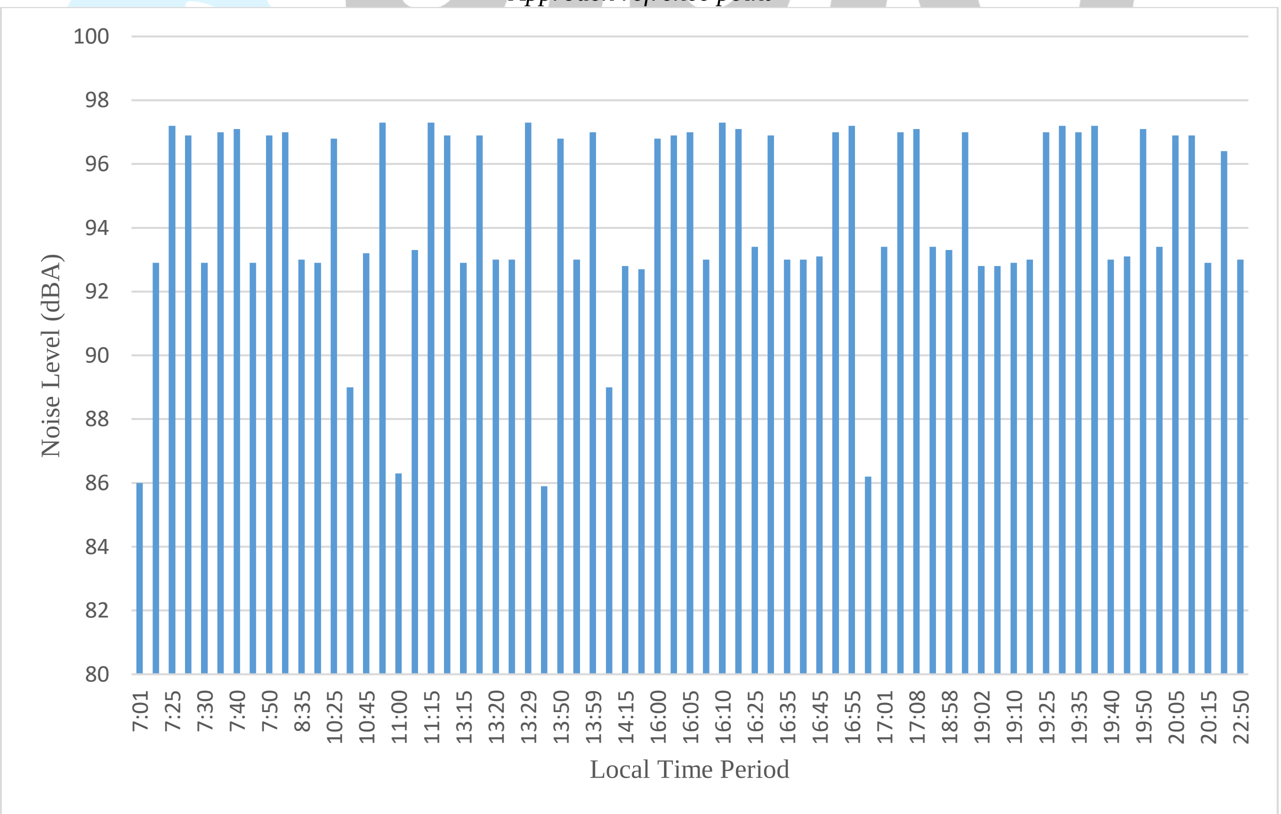

Figure 3.3: Noise level in Approach
Source: Author.2020

The diagram above is the result of measuring the noise level in the Approach reference point zone. Measurements are made at a distance of 50 meters from the flight runway so that there is no other noise interference that interferes with measurement activities. The results obtained in the form of a sample of 69 measurement data in the time range 7.01 to 22.50 local time. The range of noise levels was 86 dBA which occurred at 7.01, 11.00, 13.40, and 17.00 local time. While the range of the highest noise level is 97.3 dBA which occurs in each measurement session, namely morning, afternoon, and night. The results of the measurements carried out obtained an average of 92.37 dBA. The results of observations made, observed variations in the noise level obtained, are influenced by the type of aircraft observed. With an average of 92.37, making the approach zone the measurement zone with the highest noise level of the three previous measurement points.

3.2 WECPNL noise level coverage

When compared to the international standard CASR (Civil Aviation Safety Regulations) (2017), it says that the maximum noise level on an airplane is not allowed to be more than 108 dBA. The noise data obtained, and processed using the WECPNL method, are:

Table 3.1: *Noise level coverage*

Zone	Number of Flights		Daytime	Night Time	Day and Night time	Average	Index	WECPNL
	n	N						
	Sample	WECPNL						
Flyover	59	490	91.98	91.74	91.94	92.21	84.16	84.61
Lateral	50	414	92.52	91.14	92.33		84.55	85.06
Approach	70	558	92.25	92.94	92.37		84.58	84.97

Source: *Author.2020*

Based on the data above, when taking off and landing in the flyover, lateral and airport approach zones. The noise level of flight activities at Halim Perdanakusumah Airport obtained by the author tends to be lower, namely 84.61 dBA to 85.06 dBA (WECPNL) with an average difference of 22.4 – 23.39 dBA or has a difference of 20.7% to 21.65% compared to the standard. This illustrates that the average flight noise level at the airport is below the applicable standard threshold. When compared with the standard applied by the Ministry of Manpower No. 51, concerning the Noise Threshold Value (NAB), the values found in the workplace of 84.61 dBA to 85.06 dBA, can only be accepted by humans or field personnel for 4 hours / day. If based on the number of working hours applied is 8 hours/day, it is 50% above the safe category for personnel.

Based on research conducted by Khaki & Forouhid (2014), with similar research measurements were made at the Tehran Imam Khomeini International Airport (IKIA) in the city of Tehran, it was written that the noise level obtained around the airport area varied from 65 dBA to 80 dBA with the same standard. applicable in Iran which allows noise levels for commercial areas for personnel of 45 dBA to 65 dBA only. However, according to research conducted by Vogiatzis & Remy (2014) at Alikarnassos airport in Greece with similar research, it is said that the noise level data obtained from measurements in the airport area on the Takeoff runway are 27.7 dBA to 103.1 dBA at the closest point, and 39.3 dBA. dBA to 97.1 dBA at the farthest measurement point. Meanwhile, according to research conducted by Joshi, (2017) with similar research with a case study at Chhatrapati Shivaji Maharaj International airport in Mumbai, India, said that the data on daytime noise levels (LS) obtained was 70 dBA to 75 dBA with measuring distance as far as 400 meters from the airport. While the results of measurements at night obtained noise level data of 60 dBA to 70 dBA with a measurement distance of 1Km from the airport.

3.3 Estimated of Risk

To overcome the physiological disturbances that come from noise, in the literature obtained in research, according to the book Murphy, US Department of Health and Human Services, (2002) Estimated risk of hearing resistance to physiological attacks based on age and duration of noise exposure, listed in table 3.2 as following:

Table 3.2: *Estimated risk for hearing loss by age and duration of exposure*

Average (dBA)	5 to 10 years exposure			
	Age			
	30 Years old	40 Years old	50 Years old	60 Years old
	Risk (%)	Risk (%)	Risk (%)	Risk (%)

90	5.4	9.7	14.3	15.9
85	1.4	2.6	4	4.9
80	0.2	0.4	0.6	0.8
	More than 10 years exposure			
90	10.3	17.5	24.1	24.7
85	2.3	4.3	6.7	7.9
80	0.3	0.6	1	1.3

Source: *Murphy.2002*

Table 3.2 above shows the risk of hearing loss experienced by field personnel based on age and duration of exposure with noise intensity in the range of 80 to 90 dBA. At the age of 30 years with exposure less than 10 years, is the smallest risk that humans can experience. While the age of 60 years with noise exposure more than 10 years, is the risk of causing hearing loss is the highest. In dealing with physiological attacks on personnel, when referring to the IATA (International Air Transportation Association), countermeasures against physiological attacks in the form of noise are divided into 4, namely:

1. Intensity 150 dB(A), hazardous area and should be avoided
2. Intensity 135-150 dB (A), exposed individuals need to wear ear protection (earmuffs and earplugs)
3. Intensity 115-135 dB (A), overcome by wearing earmuffs in every work activity
4. Intensity 100 – 115 dB (A), overcome by wearing earplugs in every work activity

4. CONCLUSION

Based on the results of the study, the overall flight noise level obtained was 92.21 dBA. The adjustment for the WECPNL calculation in the Flyover reference point zone is 84.61 dBA, the roll away platform is the lateral full power point of 85.06 dBA, and the Approach reference point zone is 84.97 dBA.

The impact that occurs with noise exposure is 84.61 dBA to 85.06 dBA, on the physiology of personnel, the risk is 1.4% to 4.9%. Prevention of physiological attacks against noise, which is recommended based on IATA (International Air Transportation.

Association) standards, with a noise level of 84.61 dBA to 85.06 dBA, personnel are recommended to use ear plugs and ear muffs for every work activity.

Suggestions, further studies are needed related to surveys on the number of personnel who are actively working in the field, and the actual duration of work for each shift.

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