

“I / we confess have read this report and in my/our perspective is fulfill the scope and quality to the purpose of graduation in Bachelor Degree of Mechanical Engineering (Structure and Material)”

Signature : _____

Supervisor 1 : _____

Date : _____

**NOISE MEASUREMENT AND PREDICTION IN RESIDENTIAL
AREAS NEAR BATU BERENDAM AIRPORT**

NORHASNIRA BINTI JOHARI

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**NOISE MEASUREMENT AND PREDICTION IN RESIDENTIAL
AREAS NEAR BATU BERENDAM AIRPORT**

NORHASNIRA BINTI JOHARI

**A thesis report submitted to Faculty of Mechanical Engineering in partial
fulfillment of the requirement for the award of Bachelor Degree of Mechanical
Engineering (Structure & Materials)**

**Faculty of Mechanical Engineering
Universiti Teknikal Malaysia Melaka**

MARCH 2008

CONFESSION

“I hereby the author, declare this report entitle “Noise Measurement and Prediction in Residential Area near Batu Berendam Airport” is my own works except for quotations and summarizations which have been duly acknowledged”

Signature :

Author :

Date :

DEDICATION

Dearest my parents and sister

ACKNOWLEDGEMENT

Alhamdulillah, finally I had done research on my “projek sarjana muda” that is entitled noise measurement and prediction in residential area near Batu Berendam Airport. I would like to thank Dr.Janatul Islah Bt. Mohammad whom had been my PSM’s advisor. She had been guiding me from the beginning of the project started until I have clear vision on this project and finalized it into a report.

After all, I want to thank my parents, En.Johari B. Md.Yusoff and Pn.Noraini Bt. Musa, whom have been giving fully morale and financial support for this project. Not forgotten to Mr. Mohammad Azrul B. Saleh, the person that giving me information about aircraft engineering and airport standard for my research. Without his taught, I have known nothing on this project and the project progress will become slowest and might not achieve to the dateline.

A big thanks also Malaysia Airport Berhad (MKZ) staffs, placed where I have done the measurement on the sound pressure level. Without their information and permission, I will not be able to reach the target objectives of this thesis.

ABSTRACT

Measurement of aircraft noise in residential areas near Batu Berendam Airport is a way to know the existing noise produces by aircraft whether it will cause interruption in daily routine, quality of life and health of the neighborhood around the airport area. Aircraft noise is defined as sound produced by any aircraft on run-up, taxiing, take off, over-flying or landing. Aircraft noise is a significant concern for approximately 100 square kilometers surrounding most major airports [1]. Aircraft noise is the second largest (after roadway noise) source of environmental noise. While commercial aviation produces the preponderance of total aircraft noise, private aviation and military operations also play a role. Take-off of aircraft may lead to a sound level of more than 100 decibels at the ground, with approach and landing creating lower levels. Since aircraft landing in inner-city airports are often lower than 60 meters above roof level, a sound level above 100 dBA can be noticed. [1] In this project, noise measurement will be carried out using the sound level meter type NA-28. The data analysis will be analyzed using the software supplied together with the sound level meter. Due to the airport expansion, it is expected that the future existing noise produce by the aircraft will create more disturbances to the residential area. Therefore, prediction has to be made in order to assume the sound level will cause interruption or not. The prediction method is going to be done using suitable method such as doing a noise contouring on a map which has been designed using AutoCAD layout.

ABSTRAK

Pengukuran kebisingan kapal terbang di kawasan perumahan tempat tinggal awam berhampiran Lapangan Terbang Batu Berendam adalah salah satu cara untuk mengetahui bunyi bising yang dihasilkan oleh kapal terbang pada waktu ini, menjadi gangguan atau tidak pada rutin harian, kualiti kehidupan dan kesihatan penduduk sekitar. Kebisingan dari sumber kapal terbang bermaksud bunyi yang dihasilkan oleh kapal terbang ketika 'run-up', 'taxiing', 'take off', 'over-flying' atau 'landing'. Kesan dari kebisingan kapal terbang ini mempengaruhi utk keadaan lebih kurang 100 km persegi sekitar kebanyakan lapangan terbang. [1]. Kebisingan dari kapal terbang ini adalah kebisingan kedua terbesar kepada kebisingan alam sekitar, yang mana sumbangan terbesar adalah dari kebisingan jalan raya. Begitu juga dengan jumlah kebisingan formal kapal terbang, penerbangan persendirian dan operasi militari. Ketika sesuatu kapal terbang berlepas pasti memberi nilai lebih daripada 100 dB di tanah, dengan menghampiri-'approaching' memberi nilai rendah dari ini. Paras kebisingan melebihi 100 dB boleh dikesan disebabkan oleh pendaratan kapal terbang kebiasaannya lebih rendah dari 60 meter dari atap rumah. [1] Melalui projek ini, pengukuran tahap kebisingan akan dijalankan menggunakan alatan 'sound level meter' jenis NA-28, produk dari RION Ltd.co. Kemudian, data dari pengukuran tahap kebisingan ini akan dianalisis. Berdasarkan kepada penyata masalahbagi projek ini, iaitu projek pembesaran lapangan terbang Batu Berendam, ia dianggarkan bahawa pada masa hadapan tahap kebisingan akan bertambah dan akan memberi impak yang lebih kepada penduduk sekitar.oleh itu, jangkaan perlu di buat untuk menganggarkan paras kebisingan yang akan menyebabkan gangguan kepada penduduk sekitar. Cara untuk membuat anggaran adalah dengan menggunakan kontur kebisingan yang di lukis di atas peta dan menggunakan teknik 'layer' dalam autoCAD.

TABLE OF CONTENTS

CONFESSION	ii
DEDICATION	iii
ACKNOWLEDGEMENT	iv
ABSTRACT	v
TABLE OF CONTENTS	vii
LIST OF TABLE	ix
LIST OF FIGURE	x
ABREVIATION LIST	xi
CHAPTER 1	1
INTRODUCTION	1
1.1 BACKGROUND	1
1.2 PROBLEM STATEMENT	3
1.2.1 BATU BERENDAM EXPANSION PLANNING	3
1.2.2 NOISE EFFECT ON PEOPLE	7
1.3 OBJECTIVES	12
1.4 SCOPE	12
1.5 PROJECT MILESTONE	13
1.6 REPORT STRUCTURE	15
CHAPTER 2	16
LITERATURE REVIEW	16
2.1 SOUND	16
2.1.1 THE CHANGES OF AIR PRESSURE WHICH CAUSE SOUND	17
2.1.2 PRODUCING A SOUND	17
2.1.3 UNITS TO MEASURE SOUND	18
2.1.4 SOUND PRESSURE LEVEL	20

2.1.5	ADDITION OF NOISE LEVELS [15].....	22
2.1.6	REASONS FOR THE ACOUSTICIANS USE THE dB	23
2.2	AIRCRAFT NOISE	24
2.2.1	MECHANISMS OF SOUND PRODUCTION	24
2.2.2	AERODYNAMIC NOISE.....	25
2.2.3	ENGINE AND OTHER MECHANICAL NOISE	25
2.2.4	NOISE FROM THE AIRCRAFT SYSTEM	26
2.3	UNSAFE SOUND LEVEL.....	27
2.4	NOISE DATA FROM AIRCRAFT MANUFACTURERS	27
2.5	OVERVIEW FROM PREVIOUS WORK	29
CHAPTER 3		33
RESEARCH METHODOLOGY		33
3.1	MEASURING SOUND	33
3.1.1	SOUND LEVEL METER TYPE B&K: 2238	35
3.2	LOCATION OF MEASUREMENT.....	35
3.3	PLANNING OF NOISE MEASUREMENT	36
3.3.1	LOCATION SELECTION	38
3.3.3	ADVANTAGES OF SOUND LEVEL METER NA-28	42
3.4	NOISE PREDICTION (SOFTWARE).....	43
CHAPTER 4		45
RESULTS		45
4.1	VARIABLES TO BE CONSIDERED	45
4.2	DATA TABULATION AND ANALYSIS	48
4.2.1	WEEKDAYS	48
4.2.2	WEEKEND.....	49
4.3	NOISE PREDICTION	52
4.4	NOISE CONTOURING	53
4.5	COMPARISON BETWEEN EXISTING NOISE WITH FUTURE	56

CHAPTER 5	58
CONCLUSIONS.....	58
AND	58
FURTHER WORKS	58
5.1 CONCLUSIONS.....	58
5.2 RECOMMENDATION FOR FUTURE WORK.....	59
REFERENCES	61
APPENDIX A	64
APPENDIX B	65
APPENDIX C	67
APPENDIX D	70

LIST OF TABLE

TABLE	TITLE	PAGE
Table 1:	Effect of Aircraft Noise on Human Health	9
Table 2:	PSM 1 Schedule (July '07 to October '07)	14
Table 3:	PSM 2 Schedule (January '08 to March '08)	15
Table 4:	Subjective impression of changes in sound level (dB(A))	19
Table 5:	Reference level for sound	21
Table 6:	Table of sound levels L & corresponding SPL & sound intensity	23
Table 7:	A simple way to add noise levels.	24
Table 8:	Table of SPL data at each location during daylight	51
Table 9:	Table of SPL data at location on nighttime	51
Table 10:	Table of SPL data at location on daylight	52
Table 11:	Table of SPL data at location on nighttime	52

LIST OF FIGURE

FIGURE	TITLE	PAGE
1	Map of Batu Berendam area	3
2	Skyview of MFA and future expansion site	5
3	Small types of aircraft landed at MFA at present	5
4	Sky view of Batu Berendam Airport at present	6
5	Future Expansion of Batu Berendam Airport	7
6	A British Airways Airbus A321, showing proximity to homes	11
7	Location of noise source	29
8	Noise Measurements Location	33
9	Summary of Air Cargo Aircraft Departure Single Event Levels	34
10	An integrating-average SLM complying with IEC 61672: 2003	37
11	Sound level meter B&K: 2238	38
12	Model of microphone locations along the runway	39
13	Flow chart of measurement system	40
14	Site selection planning in red color marks	41
15	Sound level meter NA-28	43

16 a,b,c,d	Differences of Sound Pressure Level	55
17	Layout of Existing Noise Contour	60
18	Layout of Noise Contouring for Prediction	61

ABREVIATION LIST

MFA	- Malaysian Flying Academy
DCA	- Department of Civil Aviation
U.S	- United States
CDC	- Center for Disease Control and Preventions
NCEH	- National Center for Environmental Health
dB	- decibels
dB(A)	- decibels in A-Weighted
PWL	- sound power level
SPL	- sound pressure level
APU	- Auxiliary Power Unit
FAA	- Federal Aviation Administration
EPNdB	- Effective Perceived Noise Level in decibels
TOGW	- takeoff gross weight
TO	- takeoff
MLW	- maximum landing weight
APP	- approaches
SLM	- sound level meter
IEC	- International Standard for sound level meter

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Among the complex environmental effects of airport operation, the problem of noise caused by aircraft is of particular significance, because it intrudes directly on the living conditions of many people who live near the airport. Although technical developments have brought many improvements, aviation is still associated with noise [1].

The measurement of noise caused by aviation in the environment of the airport is a legal requirement. It is particularly important to analyze the development of noise emissions through long-term measurements, and thereby to check the efficiency of measures which have been implemented to reduce noise [1]. Airport activities, which are related to high noise emission levels, can be grouped in four main categories [2]:

- Flight operations: take-offs and landings.
- Taxiing

- Maintenance operations.
- Road traffic access to the airport.

This project is carried out in order to measure the existing noise in the residential near Batu Berendam Airport. Through this study, we can also predict whether the expansion planning of Batu Berendam Airport will caused more interruption on daily routine, quality of life and health of neighborhood surround it. As we can see in figure 1, there are houses and shop premises as well as schools around the airport.

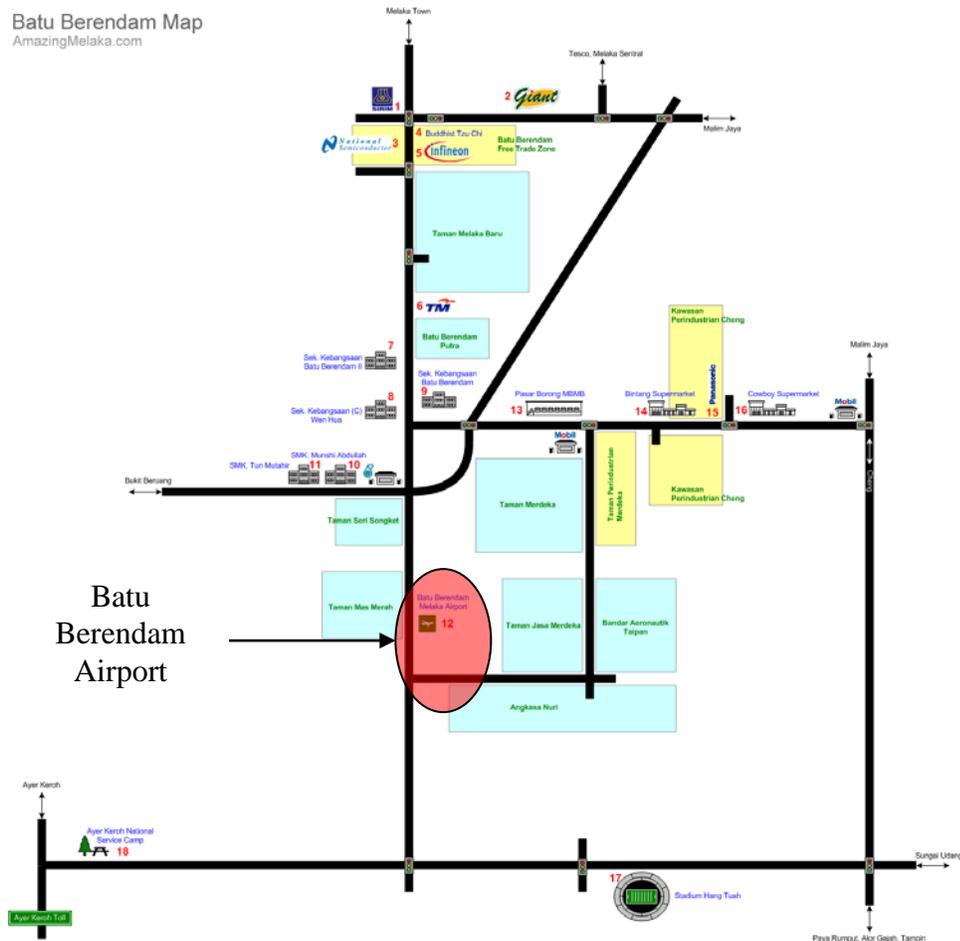


Figure 1: Map of Batu Berendam area [3]

The legends of the key landmarks are attached in Appendix A at the end of this report.

1.2 PROBLEM STATEMENT

1.2.1 BATU BERENDAM EXPANSION PLANNING

Except the local residents, not many people know about the existence of Batu Berendam Airport in Melaka. Currently, the runway is too short for big aircraft. This airport has got its earth breaking ceremony on 1 April 2006, and will be completely upgraded in 30 months. [3]

Batu Berendam Airport is occupying 141 acres of land. Under this expansion, the runway will be upgraded from 1,372 m length and 37 m width, to 2,045 m length and 45 m width. Besides, it can also allow Boeing 737 and Airbus A320 aircrafts to land. The existing terminal complex will be completely removed, and reconstructed with a 7,000 m-square new terminal equipped with international-standard amenities to cater the modern needs.

The old control tower will also be replaced with new construction, and complemented with various advanced aeronautic devices. Both ends of the runway will be installed with proper facilities to guide night landing, and better assure the safety in bad weather conditions.

Tourism, education and economic development sectors will also be benefiting from the expansion, as airway public transport is getting far more accessible than before. At present, The Malaysian Flying Academy (MFA) is occupying the major part of Batu Berendam Airport. Figure 2 shows the skyview of MFA and highlighted area that shows the expansion site of Batu Berendam Airport, while figure 3 shows small types of aircraft landed at MFA at present.

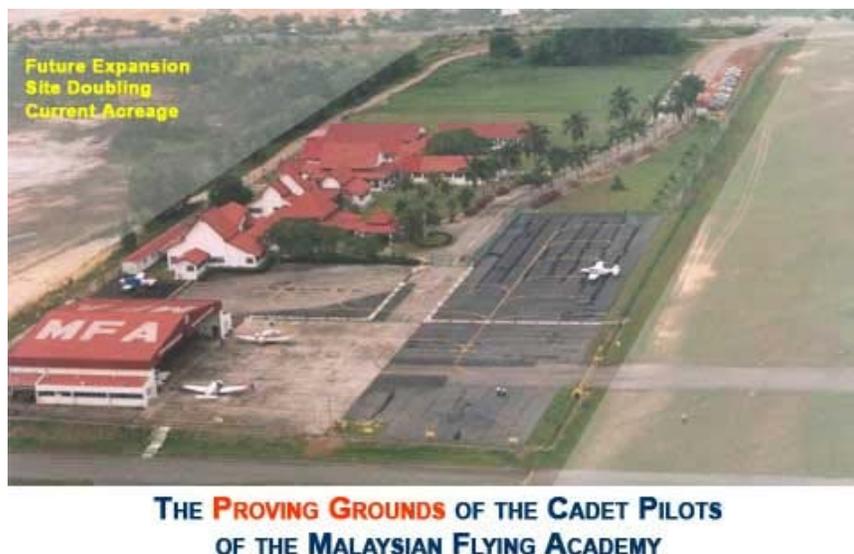


Figure 2: Skyview of MFA and future expansion site [4]



Figure 3: Small types of aircraft landed at MFA at present [4]

According to previous study in Frankfurt Airport, due to various noise sources as well as expectations regarding Frankfurt Airport's extension, it caused annoyance and quality of life of the residential area [5]. Therefore, applying the condition in Batu Berendam Expansion planning, measurement has to be carried out in order to show whether the noise produce by the aircraft will produce more disturbances in the residential area neighborhood.



Figure 4: Sky view of Batu Berendam Airport at present[4]

Figure 4 shows that the existing Batu Berendam Airport. At present, it is still under construction. In future, the MFA's hangar will be moved to another side of the airport, which is close to the residential area. It has their own building and will carry on their operation as usual when the airport had been fully expanded.

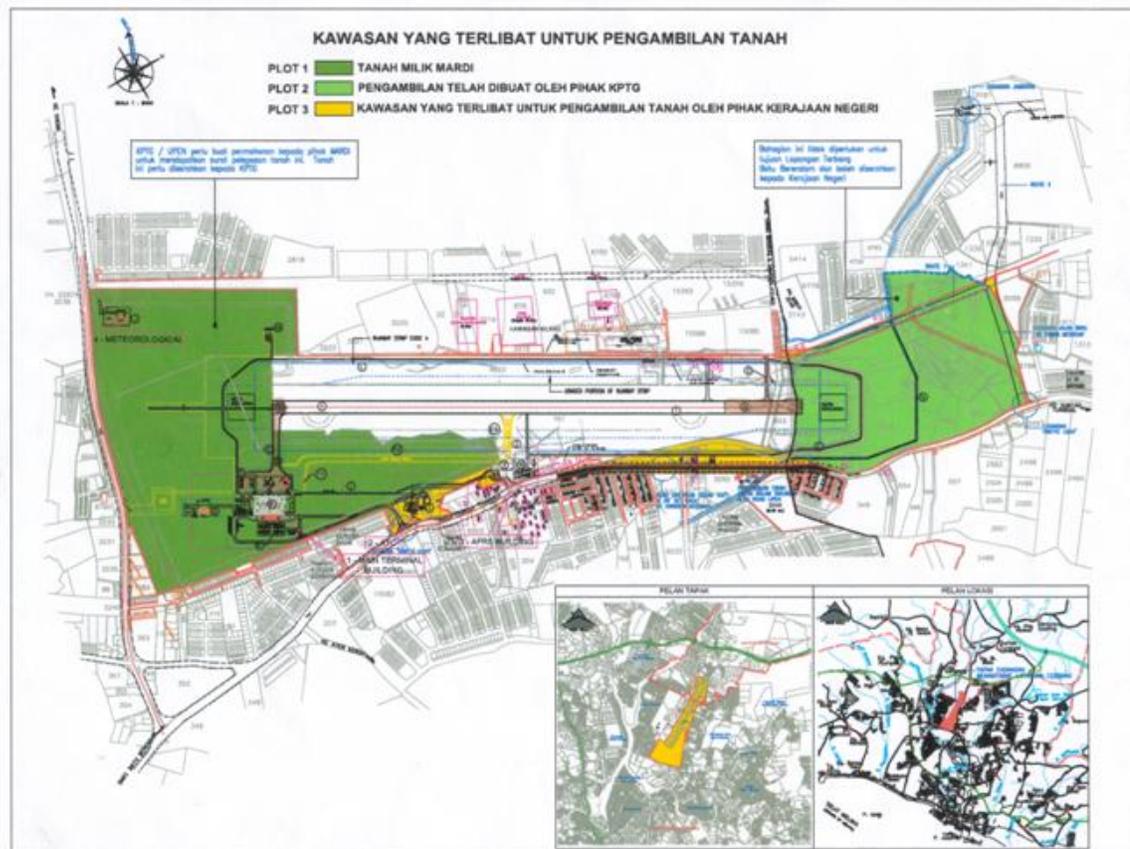


Figure 5: Future Expansion of Batu Berendam Airport [6]

Figure 5 shows that the future expansion of the Batu Berendam Airport. As being discussed previously. The old terminal will be replaced with a new fully facilitate with advance aeronautic devices.

1.2.2 NOISE EFFECT ON PEOPLE

Noise affects people in a number of ways, which can be broken down into two general categories: auditory effects (hearing loss) and non-auditory effects (activity interference and physiological effects) [7]. This project was carried out due to the expansion planning of Batu Berendam Airport. Some of the effects when the surrounding areas are exposed to a high level of noise are as listed below:

- ▶ Human health
- ▶ Children
- ▶ Quality of life

These effects are discussed in detail in the following subsections.

1.2.2.1 Human health

Interruption due to aircraft noise on human health can be classified into two categories of health that was the:-

- Physiological
- Psychological

Table 1 shows the classification of the effect of aircraft noise on human health.

Table 1: Effect of Aircraft Noise on Human Health [7]

Physiological	Psychological
Rise of blood pressure (5-10 mmHg)	Tinnitus - forgetfulness - severe depression - panic attacks
Hearing loss	Annoyance & Aggression
Coronary artery disease – heart disease	Hypertension
Immune deficiencies	High Stress Level
Neurodermatitis	Speech interference
Asthma	Sleep interference & awakening

The annoyance effects of aircraft noise are widely recognized; however, aircraft noise is also responsible for a significant amount of hearing loss as well as a contributor to a number of diseases. Only in the early 1970s did aircraft noise become a widespread topic of concern in the U.S. and federal regulations began to recognize the significance of abating these impacts in the vicinity of major commercial airports. High levels of aircraft noise that commonly exist near major commercial airports are known to increase blood pressure and contribute to hearing loss[8].

Some research indicates that it contributes to heart diseases, immune deficiencies, neurodermatitis, asthma and other stress related diseases. Further research is being carried out to better understand these effects [8]. Prior research indicates clearly that hearing loss is less a product of aging than a result of exposure to transportation related noise.

Any sound louder than normal conversation can damage the delicate hair cells in the cochlea, the structure in the inner ear that converts sound waves into auditory nerve signals. Initially damage to the cochlea may be temporary, but with repeated exposure, the damage becomes permanent and tinnitus maybe develops. More recently the Center for Disease Control and Prevention's (CDC) National Center for Environmental Health (NCEH) conducted an analysis to determine the prevalence of hearing loss among children using data collected from 1988-1994 in the Third National Health and Nutrition Examination Survey. The analysis indicates that 14.9% of U.S. children have low or high frequency hearing loss of at least 16 dB hearing level in one or both ears [8].

From research of the National Institutes of Health, roughly 65 million Americans are exposed to sound levels that can interfere with their function at work or disrupt sleep, and 25 million are exposed to health risk (cardiovascular, immunological, etc.) from environmental noise[8].

1.2.2.2 Children

In previous study, addresses the effects of aircraft noise exposure on children around London Heathrow airport, in terms of stress responses, mental health and cognitive performance. The cognitive performance and health of 340 children aged 8–11 years attending four schools in high aircraft noise areas (16h outdoor $L_{eq}>66$ dBA) was compared with children attending four matched control schools exposed to lower levels of aircraft noise (16h outdoor $L_{eq}<57$ dBA). Mental health and cognitive tests were group administered to the children in the schools [8]. Figure 6 illustrates the landing aircraft of Airbus A321, which is proximity to homes.



Figure 6: A British Airways Airbus A321, showing proximity to homes [7]

When saying about schools, we focused on children. Applying from the previous study on Postnote [9], aircraft noise will caused interruption in learning progress. This is because due to the residential area near Batu Berendam Airport, there are schools placed nearby. Therefore, in order to make assumption, the studies will be carrying out in schools area too. It is assumed that during the aircraft in operation (run-up, taxiing, takes off, over flying or landing), the sound will probably interrupt the learning process in such way:-

- i) Teachers have to repeat on their learning delivery to the student.
- ii) Speech disturbances during weekly assembly.