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The Impact of Noise on the Effectiveness of Flight Traffic Services

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Abstract: **This study aims to determine how noise affects the effectiveness of flight traffic services at Perum LPPNPI Cirebon Sub-Branch Office. The method used in this study is a qualitative one by taking three samples a day using the Sound Meter application on Android at the Menara Perum LPPNPI Cirebon Sub-Branch Office. The results of this study showed that the noise level in the control tower room had exceeded the threshold indicated both in general review based on the Decree of the Minister of Environment No. 48 of 1996 and specifically reviewed based on the book Human Factor in Air Traffic Control by V. David Hopkin in 1982. One of the reasons is the position of the tower building, which is close to the highway and adjacent to the motorcycle workshop. Based on these findings, it is recommended to install silencers, use headsets when communicating, and educate the motorcycle racing community about noise reduction**

Keywords—noise, service effectiveness, tower

I. INTRODUCTION

Along with the progress and development of transportation from time to time, especially in the field of air transportation. This development can be through various things such as increasing aircraft fleets, improving flight routes, and developing facilities in providing flight traffic services [1]. Aviation traffic is one of the important aspects in the aviation industry because it requires effective and efficient services [2].

In the world of aviation, human resources must be in prime condition as one of the determinants of safety and smooth flow of controlled traffic [3]. Human resources are said to be able to carry out work well if supported by good working environment conditions [4]. A comfortable work environment is needed by human resources to be able to work optimally and productively, therefore the work environment must be designed in such a way as to create an atmosphere conducive to human resources working in order to carry out activities in a comfortable and safe atmosphere [5].

Noise is one of the factors that are not desired by humans because in a long time the disturbing sound is able to Disturbing peace of mind at work which can cause communication errors and even serious noise can cause accidents [5]. In the Decree of the Minister of Environment No. 48 of 1996 and also reviewed specifically based on the book Human Factor in Air Traffic Control by V. David Hopkin in 1982 it is stated that noise is an activity that produces disturbing sounds at a certain level and time that can cause health and comfort problems. Environmental noise that affects ATC comfort can affect the performance of services provided to controlled traffic [6][7][8]. Noise can affect the comfort of controllers when providing flight traffic services in terms of flight safety and regularity. Based on the recommendations of ICAO Document 9426, it has been explained about the need for ATC personnel who get comfort in the work environment, in this case the control tower room is one of them that is free from noise. DOC 9426 Part III Section II Sub-Chapter 1.2 "Operational Requirements" Controllers should be able to work at their positions without physical discomfort. The environment should be sufficiently free from NOISE so as to be conducive to mental concentration" [7]. Noise standards in tower space are regulated in the Human Factor Digest 8 document about The Controller Workspace. The Human Factor Digest 8 Chapter 2 document contains standard provisions for the construction, structuring, and other matters that support ATC's performance in providing ATS services including the provisions for noise standards in tower space. "The ambient noise level in the room, preferably 55dB or thereabouts"[9].

The noise level is expressed in decibels which compares the sound pressure level. According to the World Health Organization, the sound volume level that is safe for the ear is below 85 dB for the duration of the remaining 8 hours if in the long term and above 85 dB will interfere with hearing can even be permanent [10]. Hearing loss can be classified according to a person's hearing threshold ranging from mildest to most severe as follows [11] :

TABLE I. HEARING LOSS CLASSIFICATION TABLE

Hearing Degrees	Hearing Loss
Normal	0 – 25 dB
Mild Disturbances	26 – 40 dB
Moderate Impairment	41 – 60 dB
Severe Impairment	61 – 90 dB

The effectiveness of communication itself is needed between controller-pilot to avoid and reduce the number of accidents in service delivery. However, what the author got when carrying out On the Job Training at Tower Perum LPPNPI Cirebon Sub-Branch Office was still a disruption in providing service effectiveness, namely noise in the tower which greatly interfered with transmission between the controller and pilot. From the observations made by the author, some potential dangers and disturbances that will arise from the noise to the Aerodrome Control Tower unit are the occurrence of miscommunication or miscoordination between ATC and pilots that reduce effectiveness in service delivery. For example, an error in giving instructions, when the pilot wants to ask for dual training area but sometimes what is heard is only dual training which makes it wrong in giving instructions. Then what sometimes happens, the pilot report / readback is not heard so that repetition is needed, this affects service efficiency. Repetition often occurs because the sound of the motor engine coming from the airport workshop enters the frequency, causing sound blocking at radio frequencies. This sound blocking occurs when the motor engine is heated repeatedly with a very high engine sound. This sound blocking is common during daylight hours and in the evening when the motorcyclist makes repairs in the racing motorcycle workshop.

Citing a journal at Pangkalan Bun Airport, observations that had been made there analyzed how the noise of the tower cabin on air traffic communication. At the airport, noise is caused by sounds coming from outside and inside the tower cabin such as the sound of aircraft operating in the movement area and also the sound of personnel who are not guiding the flow of traffic. In the analysis obtained, it is known that there is a discrepancy between the actual conditions in the field and the conditions that must be stipulated in the aviation regulations contained in the flight document documents so that it can affect the provision of flight services [12].

Quoting the noise journal at Banyuwangi Airport, the observation method carried out found that the cause of the noise occurred namely the presence of window glass that was not tight so that the sound of noise from outside the tower cabin entered into such as engine noise from lawn mowers and aircraft engine sounds. In the analysis, the results were obtained that the tower cabin room was not impermeable to noise caused by the non-tight tower windows so that the sound outside was still coming in [13].

In the observation of the influence of tower noise at Sentani Airport Jayapura, quoted from the noise journal due to inadequate sound damping in the tower control room, this has an impact on air-to-ground and ground-to-ground communication. From the conclusion of the analysis does not avoid that noise is indeed occurs with sound that has exceeded the threshold [7].

This study aims to determine the effect of noise on the Effectiveness of Flight Traffic Services at the Sub-Branch Office of Perum LPPNPI Cirebon so as to minimize the level of noise produced. This research is a form of theoretical application during aviation education, providing thought assistance and providing solutions to solve problems to related parties, achieving smooth operation of air traffic services, and examining the impact that occurs related to noise levels on tower cabins [12].

II. RESEARCH METHODS

Based on the predetermined goal to increase knowledge and insight, in revealing problems, methods are needed in taking rational, empirical, and systematic data [14]. By using this research method, more valid data will be obtained according to the circumstances that occur in the field. In addition, it can explain facts related to problems so that valid facts and data will make it easier to solve problems effectively and efficiently [12].

A. Data Collecting

In conducting this research using methods that aim to obtain valid data and can support the completeness of the problem-solving to be analyzed, the method used in this study is qualitative. Qualitative methods are research methods that emphasize the observation of phenomena and examine more deeply the substance and meaning of the phenomena [15]. This method is used to understand a phenomenon in depth and detail, as well as explore the meaning and experience associated with the phenomenon [15]. In this study, several data collection techniques were used to collect data related to noise in the tower: Direct observation in the tower cabin during peak hours of motor repair in a motor workshop with high motor engine sound [12].

- Interviews with ATCs to gain their experience with tower cabin noise [13].
- Measurement of noise levels using a noise measurement tool or using a sound meter application on android [16]

B. Data Analysis

The data collection method used is the direct observation method. The method is carried out by collecting data directly where the researcher directly observes the object of ongoing research [17][18]. The data collection step from this study is to determine the time and place of observation, namely direct observation every 12.00 WIB to 14.00 WIB and located next to the tower building control table at Perum LPPNPI Cirebon Sub-Branch Office. In collecting data, the author is assisted by a tool in an android application, namely Sound Meter. From the results of recording the data obtained then interpreted the results in a descriptive form whose results can be used to evaluate the effectiveness in giving opponents [12][13][19]. In addition, the author collected various facts related to examples of the causes of noise in Perum LPPNPI Cirebon Sub-Branch Office.

In this case, the author conducted a direct survey to the observation location regarding the Effect of Noise on the Effectiveness of Aviation Traffic Service Delivery. The author conducts interviews, direct observations, surveys, and literature studies in obtaining information. The interview was conducted by the author with a list of questions that had been prepared in advance to get as much information as possible about the problems that occurred so as to strengthen the author's data [7][12][13].

III. RESULT

During the job training at the LPPNPI Perum Cirebon Sub-Branch Office, approximately 3 months, the author was able to directly observe the behavior and interactions that occurred in the flight environment. The case that occurred at Perum LPPNPI Cirebon Sub-Branch Office was the noise that occurred due to the tower building adjacent to the highway and motorcycle workshop which caused quite disturbing noise. The purpose of this writing is to provide optimal air traffic services related to controller comfort in providing flight traffic services, using qualitative methods based on observations in the field, as well as related documents to the provision of air transportation services to create flight safety and security [12].

In ICAO DOC 9426 Part III Section II Sub-Chapter 1.2 has been explained about the needs of ATC personnel who get comfort in the work environment, in this case the control tower room is one of them that is free from noise and also based on the classification of the degree of hearing loss according to the International Standard Organization [7]. The noise level is expressed in decibels (dB) which compares the sound pressure level. Here are some examples of those sound levels: 60-70 dB for regular talk, 80-90 dB for heavy traffic and 140-150 dB for jet engine noise. The maximum level that the human ear can hear is 130 dB, although it is recommended that humans should not be exposed to such high sound levels [10][20].

The effectiveness of communication itself is needed between controller-pilot to avoid and reduce the number of accidents in service delivery [21][22]. However, what the author got when carrying out On the Job Training at Tower Perum LPPNPI Cirebon Sub-Branch Office was still a disruption in providing service effectiveness, namely noise in the tower which greatly interfered with transmission between the controller and pilot so that it was not effective.

Based on observations made by the author, some potential hazards and disturbances that will arise from the noise to the Aerodrome Control Tower unit are the occurrence of miscommunication or miscoordination between ATC and pilots that reduce effectiveness in service delivery. For example, an error in giving instructions, when the pilot wants to ask for dual training area but sometimes what is heard is only dual training which makes it wrong in giving instructions. Then what sometimes happens, the inaudibility of pilot reports/readbacks so that repetition is needed, this affects service efficiency [23]. The author conducted an observation sample for 3 days using the Sound Meter application on android, at Tower Perum LPPNPI Cirebon Sub-Branch Office, with the results:

TABLE II. TOWER NOISE OBSERVATION DATA TABLE

Noise Observation Data				
NO	Date	Average Noise	Minimum Value	Max Value
1	26 December 2021	81.6 dB	63.0 dB	90.2 dB
2	9 January 2022	71.0 dB	66.2 dB	72.8 dB
3	15 January 2022	72.5 dB	66.2 dB	78.7 dB

From these results it shows that the noise level in the control tower room has exceeded the threshold indicated both in general review based on the Decree of the Minister of Environment No.48 of 1996 and specifically reviewed based on the book Human Factor in Air Traffic Control by V. David Hopkin Year 1982 [6][7][8]. The causes of this problem include the following:

A. Tower Building Adjacent to the Highway and Close to the Motor Workshop

Fig. 1. Motor Workshop under the Tower

Fig. 2. The tower opposite the yellow motorcycle racing workshop

Fig. 3. Front view of moto racing workshop

It can be seen from the pictures taken that the tower building is adjacent to the highway body and adjacent to the workshop which certainly makes noise coming from outside the tower room. Examples of noise such as the sound of engines and motorcycles or cars that can enter cause noise and of course can interfere with the concentration of ATC officers.

B. Windows in Aerodrome Control Tower workspace.

Fig. 4. Window slit

In the process of providing flight traffic services, problems were found related to window density that made noise from outside the tower room can enter the cracks on the edge of the window in the workspace of the Aerodrome Control Tower unit.

Cracks in the edge of the window in the workspace make noises coming from outside the tower room can enter so that it can cause noise that disturbs the concentration of ATC officers. The noise that enters the workspace of the Aerodrome Control Tower unit is engine start-up, the sound of aircraft movement, and the sound of motor vehicles from the highway.

C. There is no silencer to suppress the noise inside the tower

The condition in the workspace of the Aerodrome Control Tower unit has not used a damper, causing the noise in the room to bounce off each other. This condition is not in accordance with what is in Document Digest 8 about Work's Space. There should be a noise absorber on the floor [9].

The provision of silencers is needed to suppress the sound of Document 9426 ATS Planning Manual chapter 2 which explains the needs of the working conditions of the tower unit in detail, precisely in section 2.1.5 of the noise that occurs in the cabin. This is set out in the Document on Specific Requirements for an Aerodrome Control Tower, namely [7] :

The room where the controller works must be completely free of noise in order to concentrate. In accordance with Document 9426 ATS Planning Manual chapter 2, Specific Requirement for an Aerodrome Control Tower sub chapter 2.1.5: The tower controller must be provided with the capability to communicate rapidly, clearly and reliably with aircraft in his area of responsibility. Normally, this is ground communications. It may accomplished through air occasionally be done by means of a light-gun from the tower using specified signals and prescribed acknowledgements from the aircraft. Since operations in and around a control tower generate a fair amount of noise (e.g. radios, aircraft engines, talking), the provision of sound deadening features in control towers is very important. Therefore, the acoustic qualities should be taken into account in the selection of structural materials used for control tower construction. Sound - deadening materials should also be used internally, e.g. carpets or similar sound-absorbent material (dust-free and anti-static, if possible) should cover the cab floor and the walls up to the window sills [7].

In the workspace of the Aerodrome Control Tower unit, the condition has not fully used a damper, so the existing noise still bounces off each other in the tower room and is not evenly absorbed. This condition is not in accordance with what is in Document 9426 ATS Planning Manual chapter 2 which explains the workspace of the Tower unit in detail, precisely in section 2.1.5 about Specific Requirements for an Aerodrome Control Tower [7].

Noise standards in tower space are regulated in the Human Factor Digest 8 document about The Controller Workspace. The Human Factor Digest 8 Chapter 2 document contains standard provisions for the construction, structuring, and other matters that support ATC's performance in providing ATS services including the provisions for noise standards in tower space. "The ambient noise level in the room, preferably 55dB or thereabouts". The statement is found in Chapter 2.28. "High noise levels are not conductive to efficient air traffic control, especially during co-ordination and liaison when background noise may be carried via radios or telephones to the pilot in the cockpit or to controllers working in other positions. Loudspeakers in ATC environments are not recommended for routine use. The ambient noise level in the room, preferably to 55dB or thereabouts. If this can be achieved, it brings major benefits because all controllers can then speak quietly to each other"[9].

This noise will affect our hearing when providing air traffic services. Broadly speaking, the effects of noise are divided into 2 major groups, namely auditory sensory disorders and non-auditory sensory disorders [24].

- Auditory Effects

In the description of noise there are 3 groups:

1) *Acoustic Trauma*: Damage to the ear due to brief exposure to high-intensity sounds. Sound sources that can cause acute acoustic trauma include gun explosions, fireworks, and explosions [25].
2) *Transient Deafness*: Deafness results from exposure to high-intensity noise. A person will experience a temporary decrease in hearing and usually the exposure time is too short. If the workforce is given enough rest time, their hearing will recover [25].

1. *Permanent Deafness*: Permanent deafness is an increase in the hearing threshold that is irreversible so that recovery is impossible. Disorders can occur in the auditory nerve or in the brain itself. This can result from cumulative effects exposure to repeated noise over many years [24].

- Non-Auditory Effects

1) *Communication breakdown*: when a person speaks in a noisy room, the person's voice will be difficult for the listener to pick up or understand, thus

disrupting ongoing communication (directly or indirectly) [26].

2) *Impaired execution of tasks*: according to some studies conducted show various sometimes contradictory results. Some conclusions that can be drawn are that interrupted noise is more disturbing than interrupted noise, work that feels easily distracted [27], and noise can interfere with the accuracy of one's work rather than the quantity of work [24][26] .
3) *Feelings of displeasure or irritability*: there are various factors that influence a person's level of displeasure, including noise characteristics including the level of intensity and frequency, a person's sensitivity to noise, individual attitudes towards noise sources, and interruptions from noise when concentrating or doing activities [24].
4) *Noise* fatigue: also increases fatigue. In thought-provoking jobs, noise is best kept as low as possible [24].

The situation in Cakrabhuwana Tower itself is found to be noise which is usually quite disturbing the work of the controller. Where sometimes vehicle sounds enter into radio frequencies that make communication between the pilot and ATC cut off. This reduces work efficiency and can even cast doubt on the accuracy of the data received by the controller on duty so that it can pose a risk to the safety of the aircraft both in the air and on the ground. From this noise arises a hazard in communication that makes us traction which when we hear the voice of the pilot and what is heard instead is the sound of a motor engine vehicle [12][13][22][28].

Please note in the document issued by the Directorate General Civil Aviation (DGCA), KM 14 Year 2009 on CASR 170 Air Traffic Rules, Sub Part 170.061 ATS Operational Requirements, Point 4 which states that the work environment must be completely free from noise in order to concentrate [29]. Likewise, Document 9426 ATS Planning Manual explains the observation of the effect of noise at airports on flight services Aerodrome Control Tower workspace [7].

From the explanation above, it can be seen that there is a discrepancy between the actual conditions in the field and the conditions that must be met which have been stipulated in the flight regulations contained in the flight documents so that it can affect the provision of flight services [12][13]. As for some alternative problem solving so that Air Traffic Control personnel can carry out their duties comfortably and not disturbed by noise are as follows:

Short-term solution steps the authors found for solving the problem:

- Install UPVC to seal cracks in windows and doors or can be by installing plaster. So that there is no air gap in the tower cabin space that allows noise to enter the tower cabin room [12].
- The use of headsets when communicating to reduce the risk of miscommunication or miscoordination and reduce the risk of disruption of the concentration of Air Traffic Controller personnel during noise [12][13].
- Conducting counseling to the community of motorcycle racing users regarding noise abatement [30].

Long-term solution steps the author found for solving the problem:

- The use of better soundproofing such as egg foam on walls, roofs, floors and frames in ATC workspaces to eliminate noise entering the room [13].
- The use of glass that is more impermeable to windows with double glass, so it is expected that the intensity of sound or noise entering the tower cabin can be suppressed to be more impermeable to noise [12].

But if we refer to Human Factor Digest 8 Chapter 2.28 which explains about handling noise problems, namely: :"Silent ventilation, carpeting, sound-absorbent plasters and curtains, and good attenuation of the workspace to preclude noise form aircraft or other external sources are the main practical means to reduce the ambient noise level in the room" [9].

And if we refer to a document such as Document 9426 ATS Planning Manual chapter 2 which explains the handling of noise problems, namely: since operations in and around a control tower generate a fair amount of noise (e.g. radios, aircraft engines, talking), the provision of sound deadening features in control towers is very important. Therefore, the acoustic qualities should be taken into account in the selection of structural materials used for control tower construction. Sound - deadening materials should also be used internally, e.g. carpets or similar sound-absorbent material (dust-free and anti-static, if possible) should cover the cab floor and the walls un to the window sills [7].

Therefore the quality of sound absorption must be considered in the selection of materials used for tower building. Sound extinguishers should also be used inside control towers, for example carpets or similar materials that can absorb sound (if possible dust-free and non-shifting) should cover floors and walls up to window sills.

Tower noise can occur due to gaps in several corners in the door and window area, causing outside sounds to enter the cabin tower. Added again the sound of sound coming from inside the tower, such as the sound of conversation which causes the sound to bounce and echo in the cabin and before the maximum silencer in the tower [12].

With CASR 170 ATS Operational Requirements Point 170.061, Human Factor Digest Document no. 8 Chapter 2.28 and Document 9426 ATS Planning Manual chapter 2 solution, closing gaps in window doors and installing soundproofing plaster such as UPVC in every crack in the window door to reduce noise from outside so as not to cause noise to enter the tower and the use of silencers that can cover the floor, wall, and up to the window sills [7][9][12].

IV. DISCUSSION

In CASR 170 ATS Operational Requirements Point 170.061, Document Human Factor Digest No. 8, Chapter 2.28, and Document 9426 ATS Planning Manual, Chapter 2, mention the addition of silencers such as carpets as a solution to reduce noise [7] [9] [12]. The addition of this silencer aims

to reduce the impact of noise that can affect performance and comfort in ATS (Air Traffic Services) system operations. In research conducted by Didiek Basuki et al., there were three vibrations of soundproofing materials tested: carpet, rockwool, and rockwool plus carpet. Test results show that these three materials can help reduce noise with leakage values that can be minimized by 5 dB to 15 dB [31]. However, it is important to note that although the addition of silencers can reduce noise, it cannot always completely eliminate it. This was also done in research conducted at the Cabin Tower Perum LPPNPI Batam Branch Office, where to minimize the noise that occurs, it is necessary to do it by installing a soundproofing coating on the tower building with routine maintenance [32].

The solution after the use of silencers in the form of carpets is the use of earphones. The earphones are designed to block unwanted background sounds. By using earphones, users can isolate themselves from the noise of aircraft engines and the surrounding environment, thus improving comfort and focus when controlling the aircraft [33]. Then some types of earphones have a noise-cancelling feature that can reduce overall noise by about 20 to 30 dB. However, some premium earphone models can achieve noise reductions of up to 40 dB or more. A noise reduction of 20 to 30 dB is effective enough to eliminate background noise such as vehicle noise, city crowds, or aircraft engines. This feature uses passive noise control and noise isolation technology to block sounds coming into the ear. Noise cancelling earphones have the main function to reduce the noise around the user. Noise cancelling technology in earphones works by generating sound waves that are opposite to background noise, so as to cancel or reduce the noise [34].

In the noise that occurs in the tower, replacing the glass of the tower building with glass more impermeable to noise, namely double glass is one solution that is often delivered. Double glass, known as laminated glass or insulation glass, has the main function of lowering noise. Noise can come from outdoors such as traffic, construction, or industrial activity, as well as from indoors such as household appliances or neighbors' noises. In this case, double glass can be an effective solution to reduce the level of noise entering the room. Double glass has the ability to reduce sound transmission to 30-40 decibels (dB). The use of double glass in window units can increase the insulation value by more than 30%, with a minimum of 2 x 6mm glass used. This happens because of the presence of a layer of air or gas between two sheets of glass that serves as a cushion to dampen sound waves. The thicker the layer of air or gas, the higher the ability of double glass to absorb and reduce noise. In addition to reducing sound transmission, double glass also has the ability to absorb sound in the room. Thus, double glass can help create a quieter and more comfortable environment in the room. Double glass can also provide additional protection from annoying external noises. By using double glass, the noise level from outside the room can be significantly reduced, thus creating a more peaceful and comfortable atmosphere indoors [35].

In terms of handling traffic conditions, the solution offered in noise control is with plants. Plants have a significant influence in reducing noise in the tower. When plants are planted around the tower, they can serve as a natural barrier that can absorb and reduce the noise produced by the tower. Some factors that affect the ability of plants to absorb noise are the type of plant, plant density, and the distance between the plant and the tower. In several case studies, the use of plants for noise reduction in towers has been shown to be effective. For example, a study conducted in India showed that planting trees around telecommunication towers can reduce noise by up to 50%. Another study in Japan also found that planting trees around power towers can reduce noise by up to 30%. Nevertheless, keep in mind that planting plants alone will not completely remove the noise from the tower. Plants can only help dampen and absorb some of the noise produced. Therefore, the use of plants must be combined with the right technology and design to achieve optimal noise reduction [36].

The installation of UPVC (unplasticized polyvinyl chloride) can have a significant effect on lowering noise. UPVC is a type of material that is often used in the manufacture of windows and doors because it is resistant to weather, durable, and has good insulation capabilities. UPVC has good sound insulation properties due to its greater thickness compared to other materials such as wood or aluminum. The thickness of the UPVC helps muffle outside sounds so that there is less sound coming into the room. In addition, the dense molecular structure of UPVC also helps reduce sound vibrations. Properly performed UPVC installation and using a double lock system or double seal system can provide good tightness and sturdiness to windows and doors. This reduces air gaps that can be an entry point for outside sound. Thus, outside noise can be minimized [13].

V. CONCLUSSION

From the solutions that have been obtained for noise that occurs at Perum LPPNPI Cirebon Sub-Branch Office, the implementation to reduce noise is the addition of carpets as helpers in minimizing noise in the tower cabin. From the use of the carpet, the results show a decrease in noise although not too significant, but it can help to reduce noise.

TABLE III. TOWER NOISE OBSERVATION DATA TABLE

Noise Observation Data				
NO	Date	Average Noise	Minimum Value	Max Value
1	August 24, 2023	54.9 dB	42.9 dB	75.6 dB
2	August 25, 2023	51.5 dB	42.2 dB	73.2 dB
3	August 29, 2023	53.8 dB	41.9 dB	75.6 dB

Table III data describes the results of a decrease in noise in the use of carpets evenly in tower buildings. The addition of this carpet is also a form to minimize noise in the tower cabin, this is in accordance with what is mentioned in the Human Factor Digest 8 Chapter 2.28 document which explains the handling of noise problems, namely "Silent ventilation, carpeting, sound-absorbent plasters and curtains, and good attenuation of the workspace to preclude noise form aircraft or other external sources are the main practical means to reduce the ambient noise level in the room" [9].

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