Noise Survey at Naval Air Stations: A Novice Approach to an Old Problem

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Abstract

Introduction: Naval personnel who are working in various air stations, ships and aircraft carrier are regularly being exposed to high level of aircraft noise. Studies have indicated that noise induced hearing loss affects 25 to 80% of crew depending on their length of exposure to aircraft noise. Presently, the aircrew, ground crew and other support staff who constitutes the major risk group are not effectively monitored for primordial prevention from the deleterious effects of noise. Lack of health awareness, improper use of Hearing Protection Devices (HPDs), inadequate health monitoring system has made the issue more critical. In this study a novice attempt was made to carry out the noise survey in the naval air stations by employing Sound Level Meter (SLM).

Methods: One fighter squadron, one transport squadron and two helicopter squadrons were selected for the noise survey. Sound Level Meter (Model-Pulsar 33) was used for collecting the noise data. A protocol was followed to determine the noise load at various occupational posts during various phases of air operations by measuring the "Equivalent Noise Level (Leq)". Parameter L_{At}, which was representative of Equivalent Noise Level (Leq) was recorded at different occupational posts during the flying. A total of 93 occupational posts in 03 different air stations were surveyed for assessing the noise level and use of HPDs by the duty personnel at these posts. These occupational posts were categorized as per the level of noise and its safety standard recommended by NIOSH.

Results: Of 93 occupational posts there were 48 (51.6 %) posts, which were found to be Noise Hazardous Posts where the noise level $\geq$ 85 dBA. At these 48 posts there were 11(22.9 %) posts where duty personnel were not using any kind of HPDs and 13 (27 %) posts where duty personnel were not using the appropriate HPDs. This study indicated that the compliance rate of adopting effective hearing protection was approximately 50%. The compliance rate of adopting effective noise protection methods were 8.3 % (aircraft dispersals), 33.3 % (hanger and open areas/verandah of squadrons), 50 % (squadron offices), 66.6 % (neighbouring squadrons, Ground Traffic Controller's posts and Take-off end of runway) and 100 % (bird shooter's location and ATC dispersals). Double Protection which is an effective means of protecting the worker at the aircraft dispersals or any other location where the noise level is $\geq$100 dBA is poorly adhered (01 against the requirement at 15 posts) to the noise safety.

Conclusions: This survey indicates that there exists a need for using "Double Protection" by all duty personnel employed in the dispersals during air operations involving various naval aircrafts.

IJASM 2017; 61(2): 48-56

Key Words: Noise Induced Hearing Loss (NIHL), Noise Mapping, Sound Level Meter (SLM), Hearing Protection Devices (HPDs), Double Protection.

Introduction

Naval personnel who are working in various air stations, ships and aircraft carrier are regularly being exposed to high level of aircraft noise. Studies have indicated that noise induced hearing loss affects 25 to 80% of crew depending on their length of exposure to aircraft noise [1,2,3]. Noise Induced Hearing Loss (NIHL) is an almost entirely preventable disability. Identification of hazardous noise areas in the air stations; stratifying the occupational categories of service personnel and monitoring their hearing acuity by conducting regular audiometric testing; providing them the training on the benefits of hearing protection; enforcing the use of personal protective equipment; administrative measures such as shorter work shifts in noise hazardous environments; and engineering

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controls are the key areas that need deliberation as a hearing conservation program for the naval personnel involved in flying duties.

Presently, the aircrew, ground crew and other support staff who constitutes the major risk group are not effectively monitored for primordial prevention from the deleterious effects of noise. Lack of health awareness, improper use of Hearing Protection Devices (HPDs), inadequate health monitoring system has made the issue more critical. As a result, there has been an increasing concern about the safety and health aspects of excessive exposure to noise in routine air operations. This study was undertaken to carry out a noise survey of various occupational posts in naval air stations with the aim of determining the amount (in dB) of protection required to limit the risk of noise induced hearing loss among naval personnel exposed to aircraft noise in these stations.

Material and Methods

Selection of Air Station

The naval aircraft inventory consists of fighter jets, transport / Maritime Reconnaissance (MR) aircraft and helicopters. Two fighter squadrons, Two transport squadrons and two helicopter squadrons were selected for the noise survey. Approval of Administrative authority of Navy was obtained prior to conduct of the study. The aviation medicine specialists along with a medical staff of the respective air stations were associated in the study to collect the noise data.

Equipment employed

A Sound Level Meter (Model-Pulsar 33) was used for collecting the noise data. The equipment used was in compliance with the international standards i.e. IEC 60651, IEC 60804 and IEC 61672 and their European counterparts EN 60651 and EN 60804. This model also complied with American standards ANSI S1.4 and ANSI S1.43. Following calibration and settings were carried out prior to its use: -

1. Calibration. MODEL 33 was calibrated before beginning a measurement by using a calibrator (MODEL100B) and its sensitivity was adjusted to 94dB. For all measurements, the MODEL 33 was set to read 93.7dB and it was ensured that, if the value of the reading differed more than + 0.3 dB from the calculated value, the sound level meter sensitivity needed adjusting.

2. Setting. Before beginning a measurement in sound level meter mode, three functions (F1, F2 and F3) and integration time (T) were configured to frequency weighting (A, C or D), time weighting (F, S or I) and the T integration time was configured by selecting 'time' units in seconds, minutes and hours. Noise data in the air stations was collected in a typical configuration of F1 for L_{AF} (A weighted sound level-fast), F2 for L_{At} (time average sound level) and F3 for LCpeak (C weighted peak) sound level.

Procedure

1. Preliminary Preparations. The preliminary preparation includes:-

   (a) Visit of the flying squadron and its neighbouring work places for interaction with aircrew, ground crew and other personnel exposed to aircraft noise while on duty.

   (b) Identifying noise hazard air operations and the locations where the crew are positioned during such operations.

   (c) Discussion of the study protocol with administrative authorities for necessary clearance.

   (d) Establishing a line of communication with the captain of the aircraft in order to obtain a noise data synchronized with engine parameter.

2. Noise data (Equivalent Continuous Noise) recording Protocol. In order to get the noise load in a particular air operation, noise data (L_{AF}, L_{At} and L_{AE}) at various work places in and around the aircraft squadron was recorded during the entire period of the air operations.

3. Data Collection. In order to determine the level of noise exposure of duty personnel at their respective occupational posts during flying, a 15 minutes noise sample was recorded. This sample noise which was representative of a noise profile of an air operation and was considered for determination of "Equivalent Noise Level (Leq)"[4]. The parameter L_{At}, which was the representative parameter of equivalent noise was recorded over 15 minutes by using Pulsar 33 (SLM).

4. Data Analysis. Software "Pulsar Acoustic Toolbox" was installed in a PC/Laptop computer and the data from the memory of MODEL 33 was transferred by using RS-232 communication port. Later the data was analysed by using "Microsoft Excel" and a free version of Statistical Package.

Results

The level of noise at various occupational posts during flying was determined from a the 15 minute-recording of noise parameter (L_{At}) by using Pulsar 33 (SLM). The values for different aircraft at different air bases are tabulated in Table 1 & 2. In order to obtain the information about Hearing Protection Devices (HPDs) being used at various occupational posts during flying, a questionnaire-based survey was conducted on duty people in the air stations. The result of the survey as per the occupational posts in the squadrons and stations are tabulated in Table 3 & 4 respectively. The International (NIOSH) recommendation for occupational noise exposure is 85 decibels, A-weighted, as an 8-hr time-weighted average (TWA) (85 dBA) [4]. Exposure at and above this level are considered hazardous. The occupational posts which recorded the noise ≥ 85 dBA was listed in the Table 5.

A total of 93 occupational posts in 03 different air stations were surveyed for assessing the noise level and use of HPDs by the duty personnel at these posts. These occupational posts were categorized as per the level of noise and its safety standard recommended by NIOSH. Of 93 occupational posts, 48 (51.6 %) posts were found to be Noise Hazardous Posts having the noise level ≥ 85 dBA. The types of hearing protection devices used by the personnel while working in these occupational posts are listed in Table 6. Of these 48 posts, there were 11(22.9 %) posts where duty personnel not using any kind of HPDs and 13 (27 %) posts where duty personnel were not using the appropriate HPDs. This study indicated that the compliance rate of adopting effective hearing protection is only 50 %. The compliance rate of adopting effective noise protection methods were 8.3 % (aircraft dispersals), 33.3 % (hanger and open areas/verandah of squadrons), 50 % (squadron offices), 66.6 % (neighboring squadrons, Ground Traffic Controller's posts and Take-off end of runway) and 100 % (bird shooter's location and ATC dispersals). Double Protection which is an effective means of protecting the worker at the aircraft dispersals or any other location where the noise level is ≥100 dBA is poorly adhered (01 against the requirement at 15 posts) to the noise safety.

Discussion

The danger to hearing can be avoided by the use of appropriate type of Hearing Protection Devices (HPDs) [5, 6, 7]. HPDs presently being used by personnel working in the air stations are essentially of two types: (a) Ear Muffs and (b) Ear Plugs. National Institute of Occupational Safety and Health (NIOSH) recommends that worker shall wear hearing protectors when engaged in work that exposes them to noise that equals or exceeds 85 dBA in "8-hr TWA (LEX)" scale. Worker whose LEX (daily energy averaged sound exposure) exceed 100 dBA should wear double hearing protection (i.e. they should wear earplugs and earmuffs simultaneously) [8]. This standard can be used as a prevention strategy for protection against Occupational Hearing Loss in naval aviation. The purpose of recording the noise level (L_{At}) at different occupational posts during flying is to stratify the exposed personnel into different risk groups depending on their level of noise exposure.

This would help to select an appropriate HPDs for the risk groups so that they are neither under-protected nor over-protected. This study identified the occupational posts which recorded ≥ 85 dBA of noise.

A total of 93 occupational posts in 03 different air stations were surveyed for assessing the noise level and use of HPDs by the duty personnel at these posts. These occupational posts were categorized as per the level of noise and its safety standard recommended by NIOSH. As per the noise data collected from various air squadrons the occupational posts can be categorized as :-

1. Mandatory Hearing Protection Posts, which further subdivided into:-
   Double Protection (DP) Posts
   Earplug/Earmuff(Ep/Em) Posts
2. Optional Hearing Protection (Opt) Posts.

Of 93 occupational posts, 48 (51.6 %) posts were found to be Noise Hazardous Posts where the noise level ≥ 85 dBA. The personnel working in these posts had a mandatory requirement to use appropriate HPDs. However, the questionnaire survey conducted on duty people working at these posts to obtain the information about HPDs had shown non-complementary results. **Out of these 48 posts there are 11(22.9 %) posts where duty personnel not using any kind of HPDs and 13 (27 %) posts where duty personnel were not using the appropriate HPDs. This study indicated that the compliance rate of**

Table 1. Aircraft Noise level (L_{At} in dBA) at various Occupational Posts in the Naval Air Stations

Sl No	Occupational Posts	Occupational Categories of Duty Personnel	L_{At} over 15 min (in dBA) during Air Ops					
			Fighter Base		Transport Base		Helicopter Base	
			F1	F2	T1	T2	H1	H2
1	Dispersal (near Aircraft / within 15 m)	Main Line Party	114.3	104.3	107.6	106.9	107.5	105.4
2	Dispersal (> 15 m)	Stand/by Line Party	111.2	108.1	106.3	106.0	105.0	105.1
3	Hanger	Ground Crew	104.1	97.9	87.6	90.3	89.0	96.0
4	Verandah	Aircrew Ground crew	99.7	94.8	88.2	85.6	86.1	88.3
5	Squadron Office (Non-AC)	Aircrew Ground crew	93.2	90.2	83.3	83	84.9	86.2
6	Squadron Office (AC)	Aircrew Ground crew	84.3	82.3	80.6	80.2	80.2	86.2
7	Squadron Office (Sound Proof)	Aircrew Ground crew	82.3	Not Available				
Fighter Aircraft Squadrons (**F1, F2**), Transport Aircraft Squadrons (**T1, T2**) Helicopter Aircraft Squadrons (**H1, H2**)								

Table 2. Aircraft Noise level (L_{At} in dBA) at various Occupational Posts in the Naval Air Stations

Sl No	Occupational Posts	Occupational Categories of Duty Personnel	L_{At} over 15 min (in dBA) during Air Ops					
			Fighter Base		Transport Base		Helicopter Base	
			F1	F2	T1	T2	86.6	85.9
1	ATC Dispersal(50 meter)	Crash & Salvage	89.5	89.3	82.3	84.8	85.3	86
2	GTC Post (50 meter)	Ground Traffic Controller	91	87.8	82.7	87.2	86.3	85
3	Runway-Take-Off End	Ground Crew	91.2	87.3	79.6	86.3	Em	Em
4	Runway-Glide Path End	Ground Crew	79.3	75.6	75.5	73.8	NA	
5	Runway- Bird Shooter	Aircrew Ground crew	95.5	88	86.3	84.3	NA	
6	Neighboring Squadron Office	Aircrew Ground crew	101.7 (310 Sqn)	88.3 (552 Sqn)	80 ('O' Schl)	81.7 (321 Sqn)	82.9 (321 Sqn)	86.1 (336 Sqn)
7	ATC Office Complex	Aircrew Ground crew	78.3	73.9	73.2	78.2	79	80.6
8	Station Briefing Room	Aircrew Ground crew	72.5	70.6	70.5	71.1	73.4	71.9
9	MET Office Complex	Met Staff	79.5	74.5	75.1	82.1	80.9	81.5
10	Station Admin Offices	Officers & Sailors	73.7	71.5	72.5	81.3	80.7	80.1

Table 3. Type of Hearing Protection used by Duty Personnel at various Occupational Posts in the Naval Air Stations

Sl No	Occupational Posts	Occupational Categories of Duty Personnel	L_{At} over 15 min (in dBA) during Air Ops					
			Fighter Base		Transport Base		Helicopter Base	
			F1	F2	T1	T2	H1	H2
1	Dispersal (near Aircraft / within 15 m)	Main Line Party	Dp	Em	Em	Em	Em	Em
2	Dispersal (> 15 m)	Stand/by Line Party	Em	Em	Em	Em	Em	Em
3	Hanger	Ground Crew	Em	Ep	N	Ep	Ep	Em
4	Verandah	Aircrew Ground crew	Em	Ep	N	Ep	Ep	N
5	Squadron Office (Non-AC)	Aircrew Ground crew	N	N	N	N	N	N
6	Squadron Office (Sound Proof)	Aircrew Ground crew	N	N	N	N	N	N
7	Station Briefing Room	Aircrew Ground crew	N	Not Available				

Em : Ear Muff **Ep** : Ear Plug **Dp** : Double Protection (both Ear Plug & Ear Muff)
N : Not using any kind of Hearing Protector

Table 4. Type of Hearing Protection used by Duty Personnel at various Occupational Posts in the Naval Air Stations

Sl No	Occupational Posts	Occupational Categories of Duty Personnel	L_{At} over 15 min (in dBA) during Air Ops					
			Fighter Base		Transport Base		Helicopter Base	
			F1	F2	T1	T2	H1	H2
1	ATC Dispersal(50 meter)	Crash & Salvage	Em	Em	Em	Em	Em	Em
2	GTC Post (50 meter)	Ground Traffic Controller	N	N	Ep	Ep	Em	Em
3	Runway-Take-Off End	Crew Ground	N	N	Ep	Ep	Em	Em
4	Runway-Glide Path End	Ground Crew	N	N	Ep	Ep	--	
5	Runway- Bird Shooter	Aircrew Ground crew	Em	Em	Ep	Ep		
6	Neighboring Squadron Office	Aircrew Ground crew	Ep (310 Sqn)	N (552 Sqn)	N ('O' Schl)	Ep (321 Sqn)	Ep (321 Sqn)	Ep (336 Sqn)
7	ATC Office Complex	Aircrew Ground crew	N	N	N	N	N	N
8	Station Briefing Room	Aircrew Ground crew	N	N	N	N	N	N
9	MET Office Complex	Met Staff	N	N	N	N	N	N
10	Station Admin Offices	Officers & Sailors	N	N	N	N	N	N

Em : Ear Muff **Ep** : Ear Plug **Dp** : Double Protection (both Ear Plug & Ear Muff)
N : Not using any kind of Hearing Protector

Table 5. Noise Hazardous Occupational Posts in Naval Air Stations

Sl No	Occupational Posts	L_{At} over 15 min (in dBA) during Air Ops					
		Fighter Base		Transport Base		Helicopter Base	
		F1	F2	T1	T2	H1	H2
1	Dispersal (within 15 m)	114.3	104.3	107.6	106.9	107.5	105.4
2	Dispersal (15 -50 m)	111.2	108.1	106.3	106.0	105.0	105.1
3	Hanger	104.1	97.9	87.6	90.3	89.0	96.0
4	Verandah	99.7	94.8	88.2	85.6	86.1	88.3
5	Squadron Offices	93.2	90.2	83.3	83	84.9	86.2
6	Neighboring Squadrons	101.7	88.3	80	81.7	82.9	86.1
7	Runway (Bird Shooter)	95.5	88	86.3	84.3	85	
8	Runway (T/O End)	91.2	87.3	79.6	86.3	86.3	85
9	GTC Post (within 50 m)	91	87.8	82.7	87.2	85.3	86
10	ATC Dispersal	89.5	89.3	82.3	84.8	86.6	85.9

adopting effective hearing protection is approximately 50%. The compliance rates of adopting effective noise protection were 8.3 % (aircraft dispersals), 33.3 % (hanger and open areas/verandah of squadrons), 50 % (squadron offices), 66.6 % (neighbouring squadrons, Ground Traffic Controller's posts and Take-off end of runway) and 100 % (bird shooter's location and ATC dispersals). **Double Protection which is an effective means of protecting the worker at the aircraft dispersals or any other location where the noise level is ≥100 dBA is poorly adhered (01 against the requirement at 15 posts) to the noise safety.**

The hearing conservation program practically followed in naval aviation is arguably aircrew oriented. The ground crew and other support staff who constitutes the major risk group are not effectively monitored for primordial prevention from the deleterious effects of noise. Studies have indicated that noise induced hearing loss affects 25 to 80% of ground crew depending on their length of exposure to aircraft noise [1, 9]. Lack of health awareness, improper use of HPDs, inadequate health monitoring system has made the issue more critical [10, 11]. As a result, there has been an increasing concern about the safety and health aspects of excessive exposure to noise in daily operations. 8-hour TWA (also known as LEX) using personal dosimeter is the parameter based on which the NIHL risk group can be identified. Presently, 85 dBA is considered as the safe noise exposure limit for an 8-hour time-weighted average (TWA); and for every 3 dB increase in noise level, the safe exposure time limit is cut in half. Noise dosimeter is a preferred method for worker who move around or who perform different tasks in an environment of varying noise level. However, for personnel remaining essentially stationary, recording of continuous noise levels using a sound level meter (SLM) having time integrated function is a preferred tool [12, 13]. SLM if facilitated with Octave and One-Third Octave function has the added advantage of frequency analysis. Studies have concluded that the tool which is suitable to identify the noise hazardous zone in air field/airbases is SLM and preferred parameters are L_{AS}, LAC_{peak}, Leq [14]. Similarly using its time integrated function the average noise level of the entire duration of exposure can be recorded. The parameter which is indicative of Leq is L_{At}. If the duration of exposure is known, LEX can be extrapolated by using a 'Leq to LEX' Normogram.

However, for noise mapping of the flying station was In this study, sound level meter was employed as a practical tool for noise mapping of various air stations. The level of noise

Table 6. Use of various HPDs during Air Ops at Aviation Occupational Posts

Sl No	Occupational Posts	L_{At} over 15 min (in dBA) during Air Ops					
		Fighter Base		Transport Base		Helicopter Base	
		F1	F2	T1	T2	H1	H2
1	Dispersal (within 15 m)	DP	DP	DP	DP	DP	DP
	Present Practice	Dp	Em	Em	Em	Em	Em
2	Dispersal (15 -50 m)	DP	DP	DP	DP	DP	DP
	Present Practice	Em	Em	Em	Em	Em	Em
3	Hanger	DP	Ep/Em	Ep/Em	Ep/Em	Ep/Em	Ep/Em
	Present Practice	Em	Ep	N	Ep	Ep	Em
4	Verandah	Ep/Em	Ep/Em	Ep/Em	Ep/Em	Ep/Em	Ep/Em
	Present Practice	Em	Ep	N	Ep	Ep	N
5	Squadron Offices	Ep/Em	Ep/Em	Opt	Opt	Opt	Ep/Em
	Present Practice	N	N	N	N	N	N
6	Neighboring Squadrons	Dp	Ep/Em	Opt	Opt	Opt	Ep/Em
	Present Practice	Ep	N	N	Ep	Ep	Ep
7	Runway (Bird Shooter)	Ep/Em	Ep/Em	Ep/Em	Opt	Not Employed	
	Present Practice	Em	Em	Ep	Ep	N	N
8	Runway (T/O End)	Ep/Em	Ep/Em	Opt	Ep/Em	Ep/Em	Ep/Em
	Present Practice	N	N	Ep	Ep	Em	Em
9	GTC Post (within 50 m)	Ep/Em	Ep/Em	Opt	Ep/Em	Ep/Em	Ep/Em
	Present Practice	N	N	Ep	Ep	Em	Em
10	ATC Dispersal	Ep/Em	Ep/Em	Opt	Opt	Ep/Em	Ep/Em
	Present Practice	Em	Em	Em	Em	Em	Em

was determined at various occupational posts by recording the Equivalent Noise Level (Leq) in a 15 min sample noise and then by using the Normogram (Leq to LEX) 8 hour TWA was obtained. By comparing the 8 hour TWA (LEX) values with existing standard (NIOSH), occupational posts could be categorized into Ear Plug/Muff (Ep/Em) post for LEX 85 to 100dBA, Double Protection (DP) post for LEX > 100dBA and Double Protection with crew rotation (DPcr) post for LEX > 115 dBA. After determining the amount of hearing protection required in a particular post, medical advice was given to use appropriate HPD in single or combination. A similar study in IAF, where analysis of on-ground and in-flight sound levels produced by Chetak and Pratap helicopters was carried out by the investigators to quantify the need for appropriate hearing protection devices [15]. This study was an attempt to carry out the noise mapping of the flying station especially various occupational posts in the technical areas by employing a SLM. There are sophisticated methods and procedures for carrying out the noise mapping of the flying stations [16,17]. However, by adhering to the good practice guides a simple device like SLM can be very effective for noise mapping [18].

Conclusions

Followings are the conclusions of this study:-

1. 51.6 % posts were found to be Noise Hazardous posts where the noise level was more than the acceptable standard i.e. ≥ 85 dBA of LEX.

2. There were as many as 11(22.9 %) posts where duty personnel were not using any kind of HPDs and 13 (27 %) posts where duty personnel were using the HPDs not providing adequate protection.

3. The compliance rate of adopting effective noise protection methods were 8.3 % (aircraft dispersals), 33.3 % (hanger and open areas/verandah of squadrons), 50 % (squadron offices), 66.6 % (neighboring squadrons, Ground Traffic Controller's posts and Take-off end of runway) and 100 % (bird shooter's location and ATC dispersals).

4. Double Protection which is an effective means of protecting the worker at the aircraft dispersals or any other location where the noise level is ≥100 dBA was poorly adopted (only in one post against the requirement of 15 posts).

Recommendations

Following are the recommendations:-

1. Sound level meters should be employed as a practical tool for noise mapping of air stations.'

2. Personnel at risk should be identified by determining the noise exposure by recording Equivalent Noise Level (Leq) in a 15 min sample noise for a particular air operation using sound level meter and interpolating LEX (8 hour TWA) by using the Leq to LEX normograph.

3. Depending upon the level of noise in a specific occupational post, these posts can be categorized into into Ear Plug/Muff (Ep/Em) post for LEX 85 to 100dBA, Double Protection (DP) post for LEX > 100dBA and Double Protection with crew rotation (DPcr) post for LEX > 115 dBA.

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