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Study on the impact of exposure to noise in professional snipers

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Abstract. Facing an increasing violence level and higher firepower in the hands of criminal organizations (especially those related to drug trafficking), the Military Police of Pernambuco has created, in 1989, the "1ª Companhia Independente de Operações Especiais" (1st Independent Company of Special Operations), as a tactical last resort of the Police to be used on special, complex situations. The CIOE progressively makes use of Negotiation measures, of less-than-lethal maneuvers, of Precision Shots and Tactical Assaults. When all possibilities are drained, the Precision Shot will bring the crisis perpetrator down. This study had as an objective to assess the level of impact noise suffered by the elite snipers of the 1st CIOE-PE in their training. The working conditions of the snipers were evaluated through the use of a semi-structured questionnaire. Noise measuring was done on four (4) .308 IMBEL AGLC (with ammo from the same lot) rifles. Six (6) shots were fired off each gun, separated by a 30-second pause. In the end, it has been concluded that the noise level the 1st CIOE snipers are submitted to is considered to be normal by Brazilian legislation.

Keywords: occupational assessment on noise, police snipers, firearms

1. Introduction

The context on which violence has appeared in Brazil (and on foreign grounds) is intricate and complex. It is clear that the current social zeitgeist is that.

Torna-se manifesto que o pensamento modulador das configurações sociais mais recentes emana de executivos das grandes empresas e seus assemelhados no comando político. Os super-ricos, indivíduos, grupo ou nações podem operar sem consideração a outros interesses que não os seus.

In this scene, the explicitly criminal organizations thrive. Organized gangs quickly spread and easily acquire heavy firearms, while the mob and drug traffic go global and replace governments of neighborhoods, cities and even entire countries.

As a result, huge parts of the national populace that are poor and are not a part of any criminal organizations tend to become the main victims, being exposed to prejudice and becoming devoid of basic citizen rights. [3]

In this context, the Brazilian government makes haste to better equip the national Police force, aiming* to intervene on and minimize social conflicts, which complexity demands a special, unordinary treatment.

In Pernambuco, through State Decree n.14.147 (september 18th, 1989), The "1ª Companhia Independente de Operações Especiais - 1ª CIOE" was created as the police's last tactical resort, acting when unordinary and extremely complex situations occurred.

The State Military Organizations of such nature are considered to be of major duty, acting in hostage situations, kidnappings, counter-terrorist and anti-bomb threats through the progressive usage of four tactical alternatives, those being the Negotiation, the Use of less-than-lethal techniques, the Precision Shot and the Tactical Assault. The Precision Shot requires a permanent training routine for the sniper due to its highly demanding nature. Due to its lethality, it is paramount that the Precision Shot must only be taken after strict authorization by the Commander of the troops, and only when all other previous non-lethal ways prove unfruitful.

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The 1st CIOE is currently made of 87 (Eighty seven) military policemen (both officers and recruits), all of which have passed through extensive specialization courses, and 5 (five) of those are official snipers. [9]

2. Objectives

To investigate the CIOE sniper's exposition to the impact noise originated from rifle blasts on training grounds, and to conduct proposals in order to mitigate any possible problems.

2.1. Specific Objectives

- Identify specific characteristics of the Sniper's training grounds.
- To quantitatively assess the noise produced by the .308 IMBEL AGLC rifle.
- To find a standard between the norms and the results obtained in the study.
- Evaluate control measures and, if necessary, suggest improvements.

3. Impact Noise

Despite the growing importance impact noise has seen due to the risk it symbolizes to the human being, there is still not an established consensus between international norms in order to establish its definition and evaluation.

In SILVA, in [8], the following definitions for impact noise can be found:

ISO-1999(1989): Sound phenomena of high level and inferior to 1sec in lenght.

Norma OSHA(1996): Sound with a rising time inferior to 35ms, referring to peak intensity, with a Lenght inferior than 500ms and a repetition time of 1s.

NIOSH(1998a): Characterized by a sudden elevation and quick sound level decrease, being less than a second in lenght.

NR15- Anexo 2(Editora Atlas,2000) e Fundacentro (1999): Level of sound with a lenght equivalent of less than a second and intervals (in between them) that are higher than 1sec in length.

In Brazil, the criteria utilized to evaluate impact noise is showcased by NR15-Anexo 2, which preconizes that the evaluation must be realized with a meter bearing an appropriate time constant and with a linear ponderation. The established threshold for this configuration is 130 dB. In case the correct equipment to evaluate impact noise is unavailable, the norm indicates the use of the time constant "FAST", with a ponderation of "C". The accepted threshold, in such a situation, is that of 120 dB. The time constant stands for the speed with which the instrument responds to time pressure oscillations, and the "FAST" constant corresponds to 125ms.

4. Hearing losses originating from shooting firearms

The use of firearms in bellicose activities since the invention of gunpowder (circa the XIV century) contributes a lot to increase hearing losses instigated by noise (COSTA, et al, in [8]). The sudden hearing loss brought upon by a high intensity (but lacking length) noise (like an explosion or detonation) is named 'acoustic trauma', and may cause severe structural harm to the both middle and inner ear.

A big acoustic trauma may lead to rupture of the tympanic membrane and/or disarticulation of the bone chain, which may be eventually corrected by surgical procedures.

In Brazil, in the year 2000, a research took place. It was about the hearing of the Escola de Formação Militar para Sargentos (Military School for Sergeants), with an involvement of 502 male individual, between the ages of 16 and 23 years. In the 20-month period between the course's beginning and end, it was noticed that 24,5% of the total had hearing losses [7]. In an evaluation of the audiologic profile of the Military Policemen of Minas Gerais, in a span of 34 male policemen between the ages of 24 an 55, 28,57% of the 7 participating snipers were shown to have PAINPSE. [16]

Its worth noticing that, according to researches made to measure the level of impact noise brought upon by the FAL (Portuguese: Light Automatic Rifle) used by units of the national army, the results pointed out numbers above the maximum level of the measuring devices utilized (that being 135 dB), which proves that the use of protective plug-type device from 3M, for an example, with a real level of noise reduction (NRRsf) equal to 12 dB is not efficient enough to ensure the user's hearing security.[12]

In a study made with 41 army men, ages around 31 to 51 years, basic audiologic evaluation detected that

39% had normal hearing and 61% already had hearing losses. [15]

There's a considerable difference (which varies from individual to individual) when it comes to susceptibility to noise. Some people have "resistant" ears and thus can tolerate way higher noise levels without suffering harm, while others are more sensible and get hurt, even when exposed to less noise. The best examples are identified within the military: Some suffer frequent hearing losses after a firing session, while others show a past of more regular exposure without having noticeable damage. [14]

In the scope of the bibliographical review that took place, it can be understood that Hearing Damage is much more frequent in people working for the military.

5. Police Snipers precision

In Brazil the use of sharpshooters in police cases occurred occasionally. From the creation of GATE (Group of Tactical Actions Spe-cial) in the Military Police of São Paulo, August 4, 1988, and had the support of teachers of the North American SWAT teaching of tactics special is that teams were organized -sniper tactics and precision weapons. [10]

6. The selection of the police sniper precision

In Brazil, the employment of snipers in police issues was occasional. After the creation of GATE (Grupo de Operações Táticas Especiais - Special Tactics Operation Group) in the Military Police of the state of São Paulo, in August 4th, 1988, (which was supported by north-American SWAT instructors who taught the discipline of special tactics), the creation and organization of sniper tactic groups went common-place. [10]

7. The sorting of the Police sniper

It is not enough to be an excellent shooter in order to be a police sniper. The policeman must be an operative of the tactic group for at least two years and take every training of its team. It is extremely important that he/she is acquainted to all operational procedures of his/her unit, for to be successful in the missions he/she is to partake in, he must know the objectives of the team and know how it will act, so he/she can provide the correct support. Due to skill and training, when necessary, the shooter can take part in other functions of the group, such as tactic assault. [1]

The sorting of the policemen must be judicious, for when pulling the trigger, in a matter of seconds, the sniper may become a hero or a villain before its superiors and society, all depending on the shot's result. If it's a hit, there's satisfaction for all and the corp.'s image is highlighted, but if it's a miss, a career gets ruined and the corp.'s reputation and image are tarnished. [5]

The elite sniper is always the first to come and the last to leave in a crisis situation. To be a police sniper, beside the mentioned requirements, the candidate must have certain qualifications which are not normally necessary for policemen or even to other members of tactic groups, such as: It is not enough to be an excellent shooter in order to be a police sniper. The policeman must be an operative of the tactic group for at least two years and partake in every training of its team. It is extremely important that he/she is acquainted to all operational procedures of his/her unit, for to be successful in the missions he/she is to partake in, he must know the objectives of the team and know how it will act, so he/she can provide the correct support. Due to skill and training, when necessary, the shooter can take part in other functions of the group, such as tactic assault. [1]

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8. The commitment to kill

We transcribed the explanation within the monography of [1]

[...] In this situation it is needed to tell the candidate that it is possible that, in any given moment of

his career as a sniper, he may have to kill someone in order to keep somebody else's right to live, and it there is hesitation over this commitment, he will be seriously jeopardizing the lives of his companions and of the people he has the constitutional duty to protect.

9. Other qualifications a sniper needs to have or to be

- Not very emotive.
- Meticulous and capable of working with a team.
- Higher-than-average intelligence.
- Excellent memory and physical fitness.
- Above-average, eagle-eyed shooter.
- Non-addicted individuals.
- Motivation, initiative, discipline, commonsense and patience.

10. Weapons used

Figure 1 – .308 IMBEL AGLC Rifle
Source: www.imbel.gov.br

The .308 IMBEL AGLC (Figures 1 and Table 1) precision rifle is based on Mauser action. With a match-type fluctuating barrel, in a .308 (7,62 x 51mm) caliber, forged by cold and adapted to be used with a scope to answer the needs of the military and the police.

Table 1
Technical details of the .308 Imbel AGLC Rifle

Fz .308 AGLC	
Ammo (mm)	7,62 x 51
Capacity	5
Length (m)	1,20
Pace (pol)	10 ou 12
Weight (g)	4700
Precision	1MOA

Source: www.imbel.gov.br

11. Noise control measures

Publications disclose that the major part of subjects who've shown hearing losses were not adequately protected: As in, for an example, the work of [17], where 17,71% did not use any kind of protection and 46,88% use only cotton as a protection device. Konopka and team (2002), quoted by [13], have analyzed ten 20-year soldiers who were not guarded by noise-protective devices and exposed to impact noise brought upon by automatic firearms and have detected alterations in the hearing of these individuals. Temmel and collaborators (1999), also quoted by [13], have made a study regarding the acoustic trauma brought upon by impact noise in military rookies and found out that 80% were not using protective devices by the time the acoustic trauma took place.

11.1. Control in the level of the noise receptor (PA)

The studies made regarding the use of the PA consider it as a last resource for ear protection. However, its use by the sniper is the only possible way to diminish impact noise on these individuals.

Considering that every PA diminished the noise forming a barrier do reduce any sound coming for the tympanic membrane, the level of protection depends on the PA's gasket level. (TOIVONEN et al., 2002 and GERGES, 1996) quoted by [2].

There are various types of auricular protection devices (Portuguese: PA), that can be used according to the wished application. The most common are: shell-shaped Earplugs and regular plugs. Simply giving the product is generally not enough to ensure the protection against aggressive agents, a wider awareness is also needed through trainings that explain how to correctly use and clean those. [17]

12. Norms and legistlation of work safety regarding noise

In Brazilian legislation, regarding the safety and work medicine, the Norma Reguladora nº 15 (1978) (Norm of Regulation number 15) sets limits of tolerance for recurring, intermittent and impact-based noise. On Anexo II (Attachment II) is where limits of tolerance for impact noise are covered. When not filtered by a PA or another protective device, impact noise of level above 140dB (measured on the circuit of noise response, or 130dB when measured a fast-responding circuit, named "FAST") is considered

dangerous. Exposition to various risk factors inside a productive procedure demands levels of caution in order to minimize such risks, be it related to the very nature of the procedure, or to the environment itself, the surroundings. NR-06 makes it clear that employers must make protective gear (Portuguese: EPI) freely available, but the Army does not have NR-06 an imperative norm, therefore carries out activities that leave the soldier without assistance when it comes to safety. It was noted, and later acknowledged by study subjects, that ear protection devices were not distributed free of charge to the rookies during firearms training. (GOMIDE, 2004, quoted by [13]

13. Meter for sound pressure level

This device is called a sound level meter (Portuguese: Decibelímetro, or Sonômetro). The device is comprised of the following basic elements: Microphone, Pre-Amplifier, adjustment options, amplifier, meter equipped with a very precise sound pressure circuit to obtain values (Portuguese: r.m.s) with constants named slow, fast and impulse, and a terminal for delivery of data. The microphone has a transducer which transforms sound waves into electric pulses which, when amplified, are utilized in the calculations of the r.m.s by a circuit dedicated to such function, which transforms the pulses into a logarithm and applies the considerations which will result in the value/level of sound pressure, in dB, instantly. There are also the time constants that symbolize the speed with which the device perceives the sound wave oscillations. These constants are normalized as slow (1s), fast (125ms) and impulse (35ms).

All sound pressure meters must obey the international norms when it comes to frequency ponderation curves, to the constants of exposure time and to the directional characteristics of the microphone. The equipments for noise measuring must be periodically submitted to calibration in laboratory.

14. Research Methodology

In this topic, the monographic work was developed under two scopes, being the Bibliographical and the Field Researches, as follows:

14.1. Bibliographical Research

The bibliographical research was done by the aid of technical and literary consulting on the characteristics of the Inbel AGLC .380 WIN Rifle, on the activities of the sniper and the precision shot, as well as the legal answer of the action. Regarding the noise, researches were done on the areas of Safety and Work Medicine and Speech Therapy, all applied to the study of impact noise as well as the surveying of current norms and legislations.

14.2. Field Research

The beginning of the survey on the Sniper's training activities was guided by the recommendation given by [6], wherein the following information lies:

" In order to make an analysis of a working place, it is necessary to "sweep" the area in order to find sources of danger, that is, inherent risks generated by the sources and determine each one: What may go wrong; when and how long; what would be the effects and consequences. On the field research, the following data was collected: Analysis of the Sniper training grounds with a description and measuring of the environment; surveying of the activities developed during the shooting training based on on-site studies, with description of the functions and interviews with the shooters. Preemptive measures were taken in consideration. The sound level meter DEC-460 from INSTRUTHERM was used for the quantitative evaluation of the impact noise levels.

15. Results

15.1. Questionnaires

The research involving the elite snipers of the 1st CIOE-PE was done through a semi-structured questionnaire, containing 16 objective questions and 1 for free answers. The research revealed a group of men with ages ranging from 35 to 40 years and a medium of 38 years. Relating their weights and heights we found body mass indexes (Portuguese: IMC) between 18,5 - 24,9, which is considered to be healthy and normal. The index is determined by dividing the individual's mass by the quarter of his height, on which the mass is expressed in kilograms and height in meters.

Everyone of them have more than 10 years of service on the Military Police of Pernambuco and only

one of them with less than 10 years in service of the 1st CIOE. On sniper duties, four of them have been doing this for 06 to 10 years, and one for 01 to 05 years. All of them completed high school or more and have completed, at least, the "Sniper" and "Approaching Techniques" by COPE - Curso de Operações Policiais Especiais (Portuguese: Special Police Operations Course). The training/shooting routine is done from 02 to 04 times a week, with a succession of 20 to 25 shots fired and being 01 to 02 hours in duration/length.

As the main characteristic of their training, 04 considered it as challenging and 01 as competitive, with no one choosing the options "part of a routine" or "tiring". All opted for concentration as the item that leaves the greatest mark on the training, with opting for "tension" or "stress". When it came to noise perception, 04 said it was bearable and 01 called it strong, with none calling it "disturbing" or "too strong". On the matter of how they consider their hearing when compared to others their age, every answered "good". The entire group went through periodic medical exams provided by the Military Police, but didn't have any hearing exams, with the last ones being appointed between 02 and 05 years ago. During training, shooters always use earplugs for protection, but there's no tradition of using two types at once. They all declare that company's current protective gear policy is good. Finally, it was asked of them what they would like to see improved on training grounds, and they said the company should make silicone earplugs in the shape of each shooter due to a better adjustment and a better noise reduction.

15.2. Training Grounds.

The 1st CIOE-PE Snipers train in an open field, close to the company's headquarters. The training grounds are more or less a hundred meters from the headquarters building. The place is 30m² long and paved with cobblestones, where the shooters gear up to train, always crouched to the ground. From the paved area there is a corridor approximately 15 meters long and 100 meters in length up to a barrier where the targets are located. There's no buildings less than 50 meters from the place, being only short and medium-height trees located at more than 10 meter from where the shooters take their places, therefore not being a barrier that can reflect sound waves. Trainings are done individually.

16. The measuring

The measuring of impact noise from the shots was made using a sound level meter from INSTRUTHERM, MODEL DEC-460-SOUND LEVEL MASTER, Nº of the bar code / Nº serial number: 05091500071903 / 05043420. The measuring was done in each one of the 04 .308 IMBEL AGLC rifles from 1st CIOE-PE, considered to be standard by the company, and with specific ammunition coming from the same lot, as described:

RIFLE 762 – AGLC - Nº AK 00101 - 3741
RIFLE 762 – AGLC - Nº AK 00088 - 5351
RIFLE 762 – AGLC - Nº AK 00102 - 3999
RIFLE 762 – AGLC - Nº AK 00098 – 557

The ammo used: M1 FULL METAL JAC -168g, LOT 2128/ 2009-CBC.

06 shots were fired with each gun, with 30 second intervals between each one, with 06 measuring being made, 03 on the left ear and 03 on the right. After 03 shots, according to the charts below, a medium was considered, therefore generating 01 value each ear per rifle.

In all cases, the measuring of the impact noise was made with the sound level meter adjusted on the C circuit and in the fast-response circuit ("FAST"), as per norm NR 15, in the 2º annex.

Table 2
Final results obtained

RIFLE	MEASUREMENT LEFT EAR	MEASUREMENT RIGHT EAR
1	97,47± 0,76dB	97,57± 0,33dB
2	98,33± 0,74dB	99,07± 0,17dB
3	98,93± 0,17dB	98,10± 0,22dB
4	99,27± 1,32dB	99,40± 0,40dB

The medium of the background noise found in the area was equivalent to MF = 44,35 dB, which does not influence the above results.

17. Discussion on the results

According to the results (Table2), it can be said that the measuring of the impact noise produced by the ammo detonation from the .308 IMBEL AGLC rifles reveal values that are relatively low for firearms, and that the measuring on the shooter level, on

both ears, are pretty much identical. However, when using the automatic rifle - FAL, caliber 7.62mm, the military shooters of the Brazilian Army are exposed to a minimum pressure level of 147,30 dB, with a chance this value might reach 171 dB. 147, 30 DB was the maximum possible value the device used in the research could register. The value or 171 dB is provided by the Revista Brasileira de Otorrinolaringologia (Brazilian Magazine of Otorhinolaryngology), as the pressure corresponding to the automatic, light rifle. [11]

It is verified that the great difference between the sound pressure generated by two mentioned weapons is that: on the automatic and semi-automatic rifles, like the FAL, the expulsion of the projectile and the reloading are made by the effect of action and reaction of the gases originated from the firing, that is, when there is pressure to oust the projectile through the barrel of the gun, the gases make equal pressure onto the back of the ammo shell, which then pushes back the mechanism that will replace the ammo for a new shot.

In this recoiling process the FAL gets open, allowing the exit, through the back, of part of the gases originated by the detonation, generating a sound pressure of 147,30 dB or more, to the shooter.[9]

Basically, every rifle used by the elite shooters are reloaded manually and that such an action, by action of a deadbolt, is held as something that grants additional precision to the shot, for it provides laying of the shell in a more consistent and firm way.

So, in the firing of a manually reloaded rifle, by reaction the gases of the blast also force the shell behind, but the deadbolt that fastens the grip does not allow any recoil to the shell, and so there is no exit of gases through the back, which makes the blast gases go only through the front, reducing the sound pressure the sniper gets submitted to. [9]

NR15, on the 2º annex, determines that the level of sound pressure from the blast (measured on the C circuit and in the fast-response circuit "FAST") must be under the threshold of 120 dB (C)

18. Conclusions

In conclusion, the impact noise resulting from the training of the Snipers from the 1st CIOE-PE is under the limits preconized by Brazilian legislation. When done individually and with the use of devices for hearing protection, the activity should not causa permanent hearing damage to these professionals. Stressing that the debate over the evaluation of impact noise is still relevant and open, and acknowledging that the training of an elite shooter is a constant throughout his entire working life, which may represent an excess above 100.000 shots fired, it is reccommended the use of double protection through the utilization of both ordinary plugs and earplugs, also, their pleas for silicone-based earplugs should also be answered, as to guarantee a mitigation greater than 10 dB on the noise they are submitted to.

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