IMPULSE NOISE LEVELS GENERATED BY A .22 CALIBER STARTER PISTOL

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1. INTRODUCTION

A .22 or .32 caliber starter pistol is commonly used in athletic events to generate a loud impulse signaling participants that the event (i.e. race) has started. Studies have been undertaken investigating starter pistols and the advantages introduced to athletes closer to the source, and also the negative image of having guns around teenagers at high school track and field events. However, there have been no published studies evaluating the noise levels generated by starter pistols.

In this paper, impulses generated from a typical .22 caliber starter pistol firing blanks will be compared to impulses generated from a .22 revolver firing both black powder blanks and standard velocity projectiles. Also, results from a .32 caliber starter pistol will also be used for comparison.

Preliminary findings on this topic were presented at NHCA in Mesa, Arizona, February 25, 2011.

2. APPARATUS AND METHODS

2.1. Apparatus

Measuring sound levels from a firearm requires a few key components; primarily the firearms as a sound source. A .22 caliber starter pistol, Italian Model 413 firing blank ammunition, and a .22 caliber revolver, Smith & Wesson K-22 Masterpiece firing both blanks and two types of standard velocity cartridges, were used for the first two experiments. The final experiment includes a Harrington and Richardson (H&R) .32 caliber starter pistol firing a Winchester .32 Smith & Wesson blank and a H& R .32 caliber revolver firing both the same Winchester .32 blank cartridge and a Winchester .32 Smith & Wesson 85 gr. lead round nose cartridge.

Moreover, since the impulses generated contain high frequency content and very high amplitude sound pressure level (SPL), we need to consider a lower sensitivity microphone of small dimensions in order to capture this acoustic data accurately. For these experiments, 1/8" microphones with a sensitivity of 1mV/Pa were selected, thereby providing a useable frequency range up to 80 kHz and a dynamic range topping at 186dB peak sound pressure level (SPL). The microphones were equipped with ¼" preamplifiers capable of carrying the potentially large signals without overloading or experiencing slew rate limitations. The power to the front end equipment was supplied by two 2-channel power modules giving us a maximum signal carrying capacity of +-60V. The power modules also feature gain and attenuation controls to adjust accordingly during testing.

Finally, a National Instruments data acquisition system, PXI 6120, was used to capture the measurements. The pertinent features of this system were the high sample rate (800kS/s), the on-board buffer (64MSample), and the trigger function. The 16-bit resolution, providing 90dB dynamic range was deemed sufficient. The data acquisition process was controlled by a custom LabView program, and post processed in MATLAB.

2.2. Setup

Three experiments were conducted using the same equipment; yet slightly different methodology was employed for each. The three experiments were designed to 1) explore the directionality of the .22 caliber starter pistols shooting blanks; 2) compare the .22 starter pistol and a .22 revolver and 3) describe the peak levels when measured from selected positions for a simulated track event.

Directionality

This looked at the directionality of the noise emitted from a .22 caliber starter pistol by placing four microphones equidistant in a 50cm radius circle around the firearm. Five shots were fired when the firearm was placed horizontally, and five shots when placed vertically.

Comparison

This experiment looked at the differences in the SPL at various spatial locations for the .22 caliber starter pistol and the .22 caliber revolver. The primary location was at the shooters left ear. The remaining three locations were at 10cm adjacent to the chamber, 10cm adjacent to the muzzle, and 10cm adjacent but 1.5m downrange.

Track Setup

Microphones were placed at the shooter's right ear and the equivalent of lane 1, 4 and 8 of a regulation sized

running track. The shooter was placed at two National Federation of High School (NFHS) suggested locations for event starter positions.

2.3. Analysis

Data was analyzed and presented in the time domain with the peak SPL value illustrated for this discussion.

3. RESULTS

The results of the first experiment revealed that contrary to prevailing knowledge a .22 caliber starter pistol was shown to produce 165 dB SPL_{peak} at 50cm distance from the shooter's ear. This exceeds many common revolvers and even rifles significantly.

The subsequent .22 comparison experiment was spawned by the findings in the first experiment. It was discovered that a blocked barrel .22 caliber started pistol produces significantly higher SPLs than a comparable .22 caliber revolver, regardless of ammunition. A sub-set of the results are shown in Table 1 below.

Table 1. Microphone at shooters ear

Firearm	Level (Pa)	Level (dB)
.22 Starter Pistol w/blanks	**3692**	**165.3**
K-22 w/CCI	1604	158.1
K-22 w/blanks	491	147.8
K-22 w/shorts	1143	155.1

Finally, the track setup experiment highlighted that with the shooter at NFHS appointed starting locations using the .32 caliber, the shooter was on average exposed to 163.2dB SPL_{peak}, whereas the runners in lanes 1, 4 and 8 were exposed to 136.6dB, 132.3dB and 127.8dB respectively. This exceeds impulse noise limits for children, as specified by the WHO (120dB).

4. DISCUSSION

The current track and field starting mechanism is almost exclusively the blocked barrel starter pistol. In fact, it is against regulations to operate open-barreled pistols, so as to avoid potentially loading projectiles and creating a dangerous situation. The problem is that the findings herein show that not only are blocked barrel starter pistols produce hazardous sound levels, they are also much louder than open barrel pistols of similar caliber at the shooter's ear position.

Clearly, the immediate conclusion from this is that, under all circumstances, the shooter should be using hearing protection in both ears. These peak levels are very hazardous for the unprotected ear, and will result in some permanent auditory loss.

Ironically there are many misconceptions regarding the SPLs generated by a starter pistol. Because of the relative small caliber (.22 or .32), many shooters and non-shooters alike jump to the conclusion that a starter pistol does not represent a significant aural danger. Moreover, because the ammunition does not contain projectiles, there is a further assumption that no physical hazard is involved. Finally, since this has been the preferred event starting mechanism for decades at youth, amateur and professional track and field events, the proliferation and ubiquity has diminished the notion of starter pistols and aural risk.

As it happens there are regulations and guidelines for what constitutes impulse noise hazards. These numbers are typically given as 140dB SPL_{peak} for adults (NIOSH) and 120dB SPL_{peak} for children (WHO). Drawing on the results from the track setup experiment, we can draw the conclusion that a majority of the athletes and potentially nearby spectators are also at risk of hearing damage. This is especially relevant for school organized events were rules and guidelines for shooter position, relative to athletes and/or spectators, may not be as clear, well-known or adhered to. There are countless examples of athletic officials firing starter pistols (without hearing protection) and being in close proximity to child-athletes. This is obviously something that should be prevented.

Finally, it is interesting to note that NCAA has an electronic starter guideline, which stipulates an impulse noise being generated by speakers from 15 feet (5m) behind the athletes at a level of 112dB. Curiously, there are no regulations for the SPL for a starter pistol. If we were to extrapolate using the inverse square law for the starter pistol, the athletic official generating a 165 dB peak SPL at 50cm should be located 256m(!) away from the athletes to adhere to the NCAA electronic starter guidelines.

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