

How Negotiators can miss Gunshots

By Officer Ken Slater, Lodi Police Department

SWAT TEAM: "Shots fired from inside the house."

NEGOTIATORS: "Negative. We're on the line with suspect and we did not hear any gunshots."

On December 6th, 2004, I was in our NOC with my team working to talk an armed man out of his residence. The man had taken his elderly mother as hostage and had barricaded himself inside his own residence. Our SWAT team had assembled and they were in their positions around the house as we conducted negotiations.

The suspect had moved into his bathroom and was talking to us on his cellular telephone. Periodically we could hear mechanical noises as he manipulated his revolver (357 S&W). As we spoke on an open recorded line with him, several of our SWAT team members announced via radio that they could hear gunshots from inside the residence. My team members and I looked puzzled at one another, and then confidently advised our SWAT team that they were wrong. We were currently speaking with the suspect and we did not hear any gunshots inside the residence.

At the successful conclusion of the incident, we determined that the suspect had indeed fired randomly at least six times towards the front of the residence during the negotiation. The suspect later told detectives that he fired the gun to, "...scare away the police", who he could hear outside his house. My team members and I reviewed the audio tapes many times; however we did not hear any gunshots.

In the months that followed, I spoke with many negotiators from different agencies regarding this incident. I heard a lot of similar stories and different theories as to why this might have happened. Using my department's indoor range, my CINT Team and I set up a test to try to determine once and for all what was happening.

With an open telephone line, which was being recorded in a different area of the building, we fired a variety of different caliber handguns while using a variety of different phones. I recorded the audio and recorded the sound pressure levels using a SPL (Sound Pressure Level) meter. We tested a large variety of cellular telephones, house phones and a throw phone. After closely reviewing the data, I determined why we couldn't hear the gunshots.

In order to understand why this happens, it's important to first understand how a microphone works.

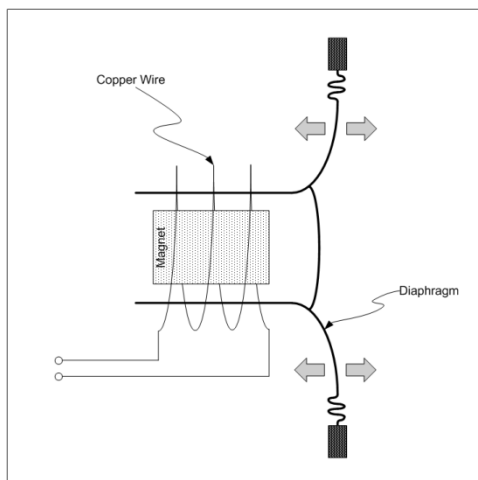


Fig #1: Standard Microphone

Microphones consist of a fixed magnet, a diaphragm and a copper wire winding, which is attached to the diaphragm in a manner that it wraps around the magnet. When the diaphragm moves, it causes the windings to move back and forth over the magnet and through the magnetic lines of flux. As the wires cut through the lines of flux, a small amount of electrical energy is induced into them. The energy level is directly proportional to the movement of the diaphragm.

A Microphone works by converting vibrations in the air into electrical energy. When a person speaks, they create high and low peaks of air pressure (vibrations) which travel through the air like a wave in the ocean. The crests and valleys of this wave press and pull against the diaphragm of the microphone. This causes the copper wire winding to move back and forth through the lines of flux, thereby generating an electrical energy copy of the sound.

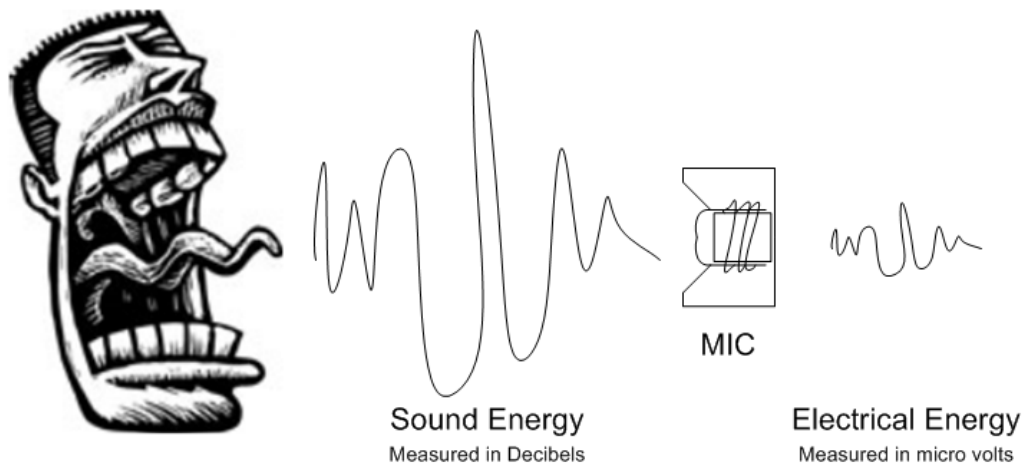


Fig #2: Transfer of Sound Pressure Energy to Electrical Energy

Microphones work well as long as they operate within their rated tolerance specifications. The diaphragm of a microphone can only move in and out so far. If sound energy is too loud, it will push the diaphragm to its maximum travel range, causing it to stop moving. If there is no movement, then the copper wires are not cutting through the lines of flux. That means no production of electrical energy.

During our range test, we recorded sound pressure levels that exceeded 130 decibels. I researched a variety of telephone type microphones and determined that their average rated maximum SPL (Sound Pressure Level) was approximately 125 decibels.

During the aforementioned negotiation incident in which I first experienced this phenomenon, our suspect was barricaded inside a 10' by 5' bathroom. When he fired the handgun, it generated a very high level of sound pressure, which compressed everything inside the room. The pressure pushed the diaphragm of his cell phone microphone all the way back and held it there until the sound pressure subsided a few milliseconds later. As the diaphragm was held in this fixed position, the microphone was affectively muted, and we did not hear the gunshot.

In reviewing the recorded waveforms, I saw a distinct peak preceding each gunshot. The peak is generated by the rapid depression of the diaphragm and was followed a few milliseconds later by its release. However between these times, the signal was electrically quiet.



Fig #3: Signal amplitude vs. time

In conclusion, it appears clear that there will be situations (not always) in which gunshots might create sound pressure levels that exceed a microphone's specifications. Had our incident occurred outside, the sound pressure would have been able to escape easily, and therefore might not have affected the microphone. Either way, it's important for negotiators and tactical team members to be aware of this limitation in their technology. Teams should never solely rely on the negotiator to be the only ear on the target building, and negotiators need to believe that their SWAT team could be hearing what they say they're hearing.

My apologies to our SWAT team.

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