The Bill Blackwood
Law Enforcement Management Institute of Texas

An Analysis of CS Tear Gas deployment with respect to Space, Time and Concentration

An Administrative Research Paper
Submitted in Partial Fulfillment
Of the Requirements for Graduation from the
Leadership Command College

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April, 2001

Abstract

The use of less lethal weapons is increasing rapidly in law enforcement and their documented use is prevalent. CS tear gas is still used regularly and successfully in confined spaces by police. However, it was hypothesized that the deployment of this agent is made without adequate documentation of the amount used. Consequently, no effort could be made to attempt to calculate a reasonable amount to deploy, given the volume of space in which the event is to occur.

A review of the literature revealed that known levels may be reached to achieve incapacitation or, in extreme cases, levels that are likely to be lethal. These clinical studies are the impetus for this research. Police training also refers to these studies and mandates the careful, measured use of this chemical agent.

This research surveyed 25 police departments of varying size that use CS gas. Over half of the respondents indicated that the amount of CS gas was indeed recorded. It was concluded that more effort is needed to ensure the safe and appropriate use of CS gas as an effective tool for law enforcement officers.

Table of Contents

Introduction

Most of the civilized world watched in horror as the Branch Davidian compound burned to the ground in Waco Texas. The subsequent, fierce onslaught of civil and criminal litigation has only recently begun to wane. Furthermore, many fringe groups in our society have fed on this event to propagate their rhetoric, bolster their extreme views and rant about the government and law enforcement being abusive. Much of the argument and disagreement from this event has been centered on the use of force to resolve the incident - specifically the high concentration of CS gas that was introduced to the compound (Heinrich, 2000). The law enforcement community has eagerly embraced the use and development of such less lethal weapons and munitions and their use is now commonplace (Rivetti, 1987). Specifically, law enforcement has successfully used CS gas to force barricaded suspects to exit structures. "Use-of Force" continua have been developed and this newer technology is sprinkled along the continuum at various places.

Less lethal options have existed for many years in the form of "Tear Gases." The recent development of pepper spray has been accepted and effectively used at an astonishing rate. It is widely regarded as a very safe less-lethal product, and many of these new products have been added to tactical team inventories. Much less attention, however, has been paid to the use of the existing CS gas that has been in our inventories for years. Yet, not until the CS gas deployment in Waco has there been so much attention paid to the toxicity of CS gas.

This paper is an investigation as to the effective use of CS gas in an urban setting, plus the documentation of this use. The proper techniques for deployment of

this chemical are somewhat standard. Tactics for space deprivation are successfully practiced and suspects are often driven to surrender. Many agencies follow up with a sound protocol of decontamination practices for those affected by the chemical and dispersion of the chemical from structures. The rapidly increasing selection of kinetic impact weapons has been accompanied by an equally large number of CS rounds for various delivery systems and one could easily argue that CS gas will be used more often as more delivery variations are manufactured.

The toxicity of CS gas is also well known and documented by manufacturers (Defensive Technologies, 2002). Formulae allow one to calculate a relatively accurate amount of CS gas to deploy to a given volume of space over a period of time to achieve the desired effect. These formulae have two distinct benchmarks. The first is an incapacitating concentration where 50% of those subjected are likely to be strongly affected. Next, there is a lethal concentration point where 50% of those exposed are likely to die (U.S.Army, 2002).

One may calculate these concentrations using the amount of gas used in a given volume of space (typically in a home or building) related to the time that one is exposed to the gas in milligrams per minute per cubic meter (Ijames, 1999). While the lethal doses of CS gas are indeed extreme, factors such as volume, time and ventilation compromise the safety factor considerably. Open air use of CS gas for riot control has been lauded for years as a highly effective tool. The open-air use provides immediate ventilation and virtually eliminates the possibility of reaching a lethal level. Again, it is the indoor, confined use of CS gas and similar chemical munitions that merits attention.

Law enforcement groups have become much better at planning and documenting unusual occurrences such as High-risk warrant services, hostage incidents and barricaded persons. Given the litigious actions that encompass use-of-force issues, documentation must exist to show that consideration was also given to the amounts of gas used (Meyer, 1992). The risks are clearly identified and the consequences of misuse are grave.

To research what training, use and documentation efforts are currently in effect in the law enforcement community, a survey questionnaire was sent to 100 police departments that have been identified to use CS gas. The questionnaire solicited information as to training, deployment considerations and subsequent documentation of use. Analysis of the data gathered points to a picture of how well law enforcement is using CS gas.

It was hypothesized that research would find that the amount of gas introduced per unit of volume is seldom considered and poorly documented. Furthermore, it was expected that little is known as to the risks associated with using CS gas and the accepted decontamination practices. This combination of assertions, if true, will potentially expose law enforcement to a great deal of exposure to liability, at best. This study will benefit law enforcement by educating those yet unaware of the finer points of CS gas and serve to validate the practices of organizations that fully consider the consequences of misuse.

Literature Review

This section will present a cross-section of the relevant body of information surrounding the use of chemical munitions. Government reports, manufacturers, professional research efforts, training seminars, newspaper reports and web pages contribute to the body of knowledge. These sources vary in weight from classical, clinical studies performed at the inception and creation of CS gas in the 1960's to less scientific papers on down to anecdotal stories.

The information is generic on the clinical and governmental side of the scale and losses validity and confidence at the other end where many Internet sources cite the scientific studies, but are awash in political activism that is mostly at odds with present public policy. This information becomes even more limited with regard to lethal concentrations over a period of time. There simply is no reliable database of injuries related to CS gas deployment. However, the fact that there are clinical sources that identify the existence of these incapacitating and lethal levels motivate the need to research law enforcement's treatment of this issue.

The majority of clinical and government/military sources offer little more than spreadsheets of data with basic, similar descriptions of effects and decontamination protocols (see figure 1). Worse, these sources lack specific examples of real-world lethal scenarios. Moreover, there is virtually no authoritative research to compare and validate the present usage of these gases.

Riot Control (Incapacitating) Agents *Substances that rapidly produce temporary disabling effects.*					
Name! Symbol	Means of Exposure	Lethal Dosage[2]	Rate of Action[3]	Effects	Antidotes/ Methods of Treatment
Tear Agent 2 (CN)	Inhalation	7,000 LCt_{50}	Rapid	Instant pain in eyes and nose; tearing induced; coughing; chest tightness; vomiting if high doses are swallowed or if individual is especially sensitive	Relocate to fresh air Thorough washing of exposed eyes and skin with water Effects generally dissipate within 15 to 30 minutes of departure from contaminated area
Tear Agent 0 (CS)	Inhalation	61,000 LCt_{50}	Rapid	Instant pain in eyes and nose; tearing induced; coughing; chest tightness; vomiting if high doses are swallowed or if individual is especially sensitive	Relocate to fresh air Thorough washing of exposed eyes and skin with water Effects generally dissipate within 15 to 30 minutes of departure from contaminated area

(Tear gas online, 2002)

Building on this theme, the United States Army (2002) refers to CS gas as "immediately dangerous to health and life at a concentration above two milligrams per cubic meter." This statement is direct, but fails to address the critical issue of time when calculating the risks. Dr. Uwe Heinrich (1993) wrote to a special counsel investigating the use of copious amounts of CS gas at the Branch Davidian compound in Waco, Texas, he also identified the recurring issues of gas concentration, time, and volume. What made his research stand out was his treatment of the space in a structure as not just space, but the aspect of the affected individuals inability or unwillingness to leave the confined space.

This notion opens a door to a whole new dimension of consideration that is clearly critical to domestic law enforcement. This dimension involves a target structure

occupied by more than just the primary suspect. In many situations, the offenders regularly hold innocents as hostages that cannot readily leave the area. These realities stand as profound social, political and legal considerations for police officers and their departments when using weapons like these that are indiscriminate. The legal environment surrounding CS gas is largely untested when compared to that of impact weapons and other use-of-force issues. Often times, chemical munitions are omitted from use-of-force continuums.

Law enforcement must be trained to use these weapons using the best decision making possible, given the risks at hand. Much of the operational research and study for police officers has centered on the efforts of Colonel Steve Ijames of the Springfield, Missouri. He is a widely recognized expert in the training and deployment of myriad less-lethal weapons for police officers. His training curriculum strongly emphasizes the absolute necessity to calculate the ICt-50 and LCt-50 equations as accurately as practical whenever deploying chemical munitions. Ijames does point out, however, that while the lethal concentrations are clinically proven, it is very difficult to reach those levels, even under extreme, real-world applications. Hence, the extra effort to calculate and document CS usage is commonly thought of as unnecessary. Ijames counters that even though it may be difficult to kill someone with CS in a typical structure, amounts greatly in excess of an incapacitating level could make a case for excessive force.

In addition, his curriculum encompasses a number of decontamination protocols for both people and property. The notion of property contamination, while obviously not as critical as an accidental death, still merits some consideration.

The pervasive and persistent nature of CS gas should also be considered when deciding how much of the agent to deploy. More than a month after Montgomery County Police shot nine canisters of CS tear gas into a home to force out a gunman who refused to surrender, the owner of the house complained that they still could not occupy the home because the gas left a residue behind on the inside of the home. One estimate from a cleaning service (which included vacuuming all the surfaces and washing all the (ceilings, floors and walls with a solvent solution) was just under $20,000 (Allanach, 1995). This story illustrates that the proper, just and legal use of chemical munitions may have unintended consequences. The issue of unintended consequences is something that the law-enforcement community must work to evaluate and understand.

Methodology

It has been shown that there are inherent problems associated with the use of chemical agents As with most less-lethal weapons systems, death can occur under certain circumstances. It has also been shown that the amount of agent, exposure time and volume of space are the key issues related to the effective use, or misuse of CS gas. Again, the motivation of this paper is to research the current ideas, knowledge and use of CS gas in law enforcement today. Solid use-of-force policies are commonplace in contemporary police departments and are generating detailed use-of-force policies with equally impressive training schedules. Many of these agencies make extra efforts to document their use-of-force and make adjustments to their weapons inventories and training. The issue here is whether the attention has mainly fallen on the newer technologies.

This paper attempts to answer this question by surveying a number of police departments that use CS gas to learn if they record the amount of CS agent deployed and if ICt-50 or LCt-50 calculations are made. Analysis of the data gathered should provide a clear picture how well law enforcement is using CS gas in light of the established potential consequences.

As stated earlier, it is hypothesized that the analysis will indicate that the amount of CS gas deployed is not completely recorded and that the LCt-50 and ICt-50 calculations are seldom performed. The data sample consists of 25 agencies of varying size from across the state that confirmed that they do use CS gas. Once the use of CS gas was confirmed, the contact person was asked if the amount was recorded. This single question was selected for a number of reasons.

First, the amount is the easiest to determine as most delivery systems are clearly labeled with the exact content of CS agent. Time and volume, on the other hand, are more difficult. Calculations for volume are best guesses given the fact that the police typically know very little about the inside of the target structure. Furniture takes up volume and varying ventilation affect the concentration of the agent. In addition, the calculation of time and concentration is compromised by the varying times of multiple volleys of gas.

Second, if this question elicits a negative answer, there is no need to pursue issues of time and volume. Moreover, without this critical measure, the LCt-50 and ICt-50 calculations are certainly not performed. Finally, this question appears to be innocuous at face value and is intended to be unassuming to help ensure more accurate responses.

Findings

Of the 25 contacts using CS gas, 14 responded that do indeed record the amount used. Seven of the contacted agencies using CS gas did not record the amount used and four responded that it was unknown if the amount was recorded.

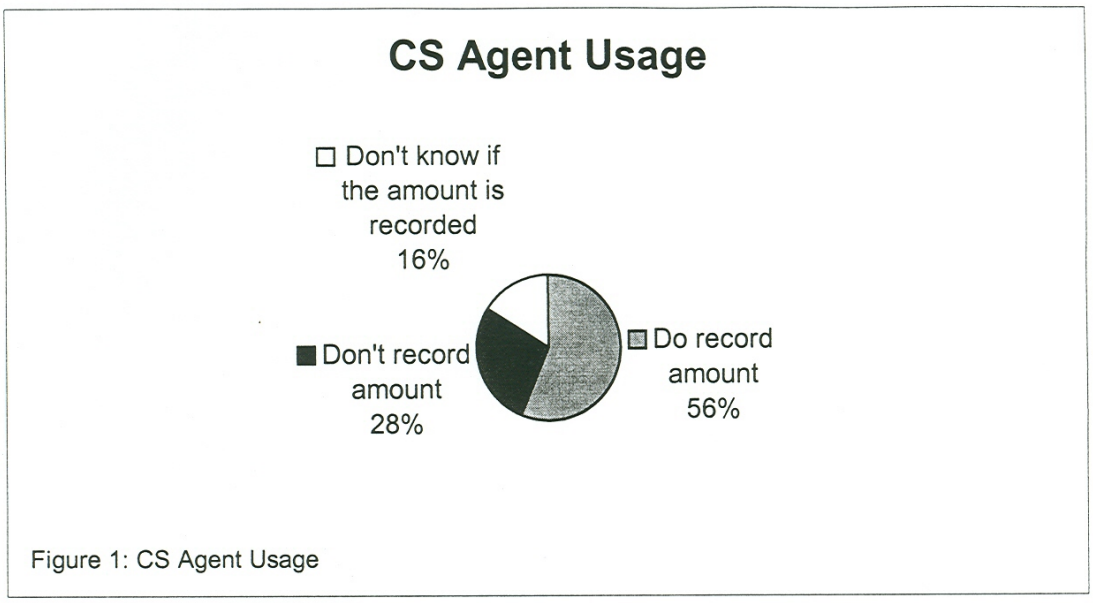

Figure 1: CS Agent Usage

This data supports the author's original hypothesis and indicates that there is a statistically significant portion of those using CS gas that are not measuring the amount of agent used. However, one must be careful in reaching conclusions from the data gathered here. While it is safe to say that the numbers here clearly represent a deficiency regarding the reported use of CS gas when compared to the significant issues raised by the literature reviewed, there are more questions raised that should be addressed by further research.

One factor is the anecdotal nature of this survey. There simply is not a great number of centrally located data that documents true use of CS gas by contemporary

police departments in confined spaces. The lion's share of CS gas deployments is in open areas to assist in crowd control. These smaller numbers, both in the sample size and the frequency of actual deployments with CS gas, do limit the accuracy of this research. Despite these spurious factors, it still stands to reason that to not record the amount of CS agent used is a poor practice when faced with the possibility of defending police actions against excessive use-of-force litigation. An ounce of prevention truly could be worth a pound of cure.

Conclusions

Is there a need for improvement in the measure, calculated use of CS gas in modern policing? It appears that the answer is yes. It was hypothesized that a significant number of police departments were failing to record the amount of CS agent deployed and the data tends to confirm this. From this research, it is clear that more investigation and research is necessary for a number of reasons. More detailed survey questions should be asked to a larger number of diverse agencies to examine more dimensions of this issue. Tactical reports could be researched to extract data about suspect behavior to measure the fit between the clinical expectations of CS gas deployment and actual field results. The absence of documented cases associated with over exposure to CS gas limit the weight one can attach to the true consequences of not performing the measurements and calculations. Continued and expanded research in this area would clearly extend and possibly validate this research effort. Despite the spurious factors identified here, the fact remains that better documentation of CS gas deployment is truly needed.

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Survey Questionnaire

I am conducting research as to the present uses of **CS *tear gas*** by police departments and tactical teams to force barricaded suspects to exit structures. This research is a part of my work as a student of the Bill Blackwood Law Enforcement Management Institute of Texas.

Please take a moment to complete and return this *anonymous* survey. I hope that the analysis of this information will contribute to the general knowledge of such less lethal technology and assist police departments in the proper deployment such tools.

Please circle answers below -

1. Does your agency use CS gas to force suspects from structures?

   Yes *No* *Unknown*

2. Does your agency use OC gas to force suspects from structures?

   Yes *No* *Unknown*

3. Is the quantity of the product deployed recorded as it is deployed?

   Yes *No* *Unknown*

4. Is the time of the gas deployment recorded to monitor exposure times?

   Yes *No* *Unknown*

5. Are calculations made to determine the approximate volume of the structure?

   Yes *No* *Unknown*

6. Is the data gathered documented?

   Yes *No* *Unknown*

Thank you for your time in completing this survey.

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