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ANNOTATION:

THE PURPOSE IS TO PROVIDE LAW ENFORCEMENT PERSONNEL WITH THE INFORMATION NEEDED TO MAKE SOUND DECISIONS IN THE USE OF CHEMICAL AGENTS TO ACHIEVE POLICE OBJECTIVES.

ABSTRACT:

AT THE EXECUTIVE LEVEL SUCH DECISIONS INVOLVE THE FORMULATION OF POLICY AND PROCEDURE THAT PROVIDE THE BASIS FOR ALL DEPARTMENTAL CHEMICAL OPERATIONS. IT IS OFTEN SAID THAT POLICY DECIDES WHAT IS TO BE DONE AND PROCEDURE DIRECTS HOW IT IS TO BE ACCOMPLISHED. THERE IS NO AREA OF POLICE ACTIVITY IN WHICH POLICY AND PROCEDURE ARE MORE IMPORTANT THAN IN THOSE SITUATIONS INVOLVING THE USE OF FORCE. SINCE CHEMICAL MUNITIONS, LIKE FIREARMS, ARE ESSENTIALLY DEVICES FOR THE APPLICATION OF FORCE, THE DEVELOPMENT OF GUIDELINES FOR THEIR EMPLOYMENT IS A COMMAND RESPONSIBILITY AND AN OPERATIONAL NECESSITY. FOR THE POLICE ADMINISTRATOR, THE ISSUE IS NEVER WHETHER HIS ORGANIZATION WILL HAVE A POLICY IN RELATION TO THE USE OF CHEMICAL AGENTS, BUT ONLY WHO WILL ESTABLISH SUCH POLICY. IN THE ABSENCE OF DIRECTION FROM ABOVE, EACH OFFICER WILL ESTABLISH HIS OWN POLICY AND HIS DECISION MAY OR MAY NOT REFLECT THE DESIRE OF THE CHIEF EXECUTIVE, WHO IS ULTIMATELY HELD RESPONSIBLE FOR THE CONSEQUENCES OF ACTION IF TAKEN BY OPERATIONAL PERSONNEL. THERE IS ALSO CLEAR OBLIGATION ON THE PART OF THE POLICE LEADERSHIP TO PROVIDE GUIDANCE FOR OFFICERS EXPECTED TO FUNCTION UNDER DIFFICULT FIELD CONDITIONS. IT IS BOTH UNWISE AND UNFAIR TO PERMIT OPERATIONAL PERSONNEL TO CARRY OUT THEIR RESPONSIBILITIES IN WHAT AMOUNTS TO POLICY VACUUM. (AUTHOR ABSTRACT)

POLICE CHEMICAL AGENTS MANUAL

THOMPSON S. CROCKETT

INTERNATIONAL ASSOCIATION OF
CHIEFS OF POLICE, INC.

PROFESSIONAL STANDARDS DIVISION
WASHINGTON, D. C.

CHEMICAL AGENT DATA SUMMARY*

Riot control agents are local irritants which in very low concentrations act primarily on the eyes, causing intense pain and lacrimation. High concentrations produce irritation of the upper respiratory tract and the skin and, with CS, nausea and vomiting as well. These agents are dispersed in the air as aerosol clouds. The lacrimators or tear agents used by police agencies are chloroacetophenone (CN) and o-chlorobenzalmalononitrile (CS).

CN	CS
PROPERTIES CN is a white crystalline solid, melting at 129° F (54° C). CN is used sometimes in liquid form by dissolving it in appropriate solvents. The odor, if any, of CN may be faint and agreeable. It may appear as a bluish white cloud at the point of release. Solid lacrimators are dispersed as a mixture of vapor and fine particulate smoke by burning type munitions such as projectiles and grenades. The vapor pressure of CN is so low that, although effective lacrimating concentrations can be produced easily in the field, skin-irritating concentrations do not commonly occur except in inclosed spaces.	**PROPERTIES** The agent CS is a white crystalline solid and is stable under ordinary conditions of storage. It has a pungent pepper-like odor. The CS cloud is white at the point of release and for several seconds after release. CS is disseminated by burning, explosion, and aerosol formation. CS is faster acting, more potent, and less toxic than CN. In terms of agent weight, the effectiveness of CS is about 10 times that of CN. One-tenth of an ounce of CS will produce about the same results as 1 ounce of CN.
SYMPTOMS This lacrimator produces sharp irritating pain in the eyes, resulting in immediate blepharospasm and a copious flow of tears. If exposure is brief, these effects last only a few minutes. More prolonged exposure causes mild conjunctivitis, some photophobia, and a desire to rub the eyes. There may also be a moderate sense of irritation in the nose and a stinging sensation of the skin, particularly in hot weather. A generalized dermatitis may occur rarely, with sweating skin.	**SYMPTOMS** When an unmasked person walks into a cloud of CS, the effects are felt almost immediately. Incapacitation begins in 20 to 60 seconds. Duration of effects is 5 to 10 minutes after the individual is exposed to fresh air. During this time the affected individual is incapable of effective concerted action. There is extreme burning of the eyes and copious flow of tears; involuntary closing of the eyes; sinus and nasal drip; coughing; difficult breathing, and tightness of the chest, and, in some cases, panic. In addition, following exposure to high concentrations of CS, there is nausea and vomiting.

*For detailed information see Chapter Two, *Introduction to Police Chemical Agents.*

POLICE CHEMICAL AGENTS MANUAL

Thompson S. Crockett

Assistant Director
Professional Standards Division, IACP

INTERNATIONAL ASSOCIATION OF CHIEFS OF POLICE, INC.
PROFESSIONAL STANDARDS DIVISION

PREVENTION
CONTROL

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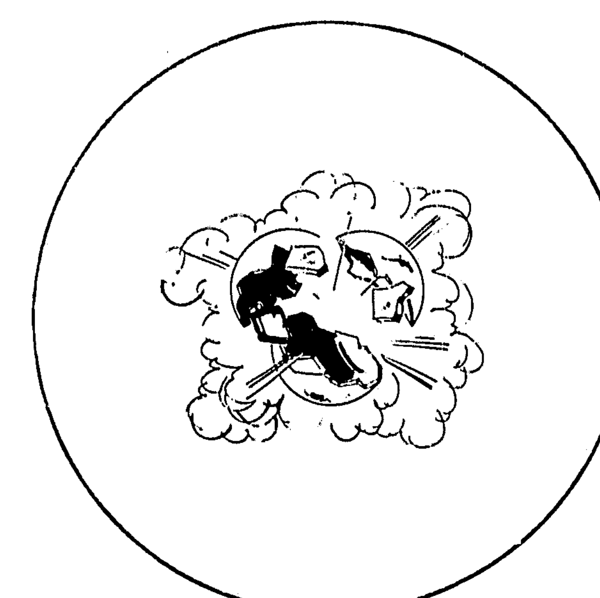
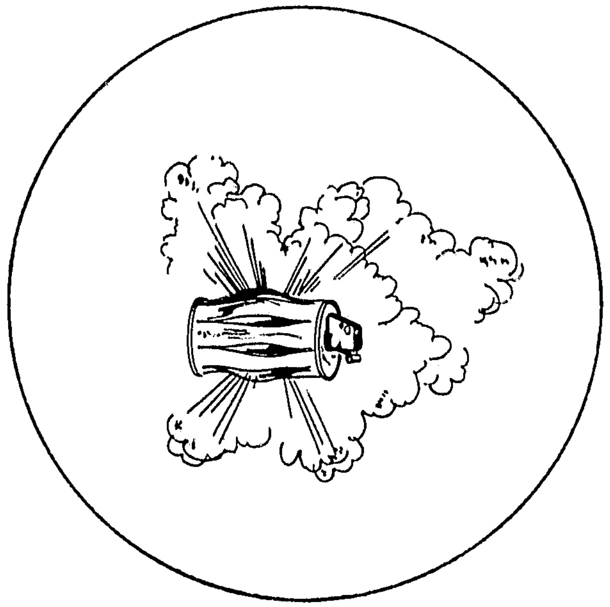
This document was produced as part of the information dissemination service of the Chemical Agents Program conducted by the International Association of Chiefs of Police, Inc. for the U.S. Department of Justice under LEA Contract 68-37.

Persons undertaking such projects under government sponsorship are encouraged to express freely their professional judgments, findings, and conclusions. Therefore, points of view or opinions stated in this document do not necessarily represent the official position or policy of the U. S. Department of Justice.





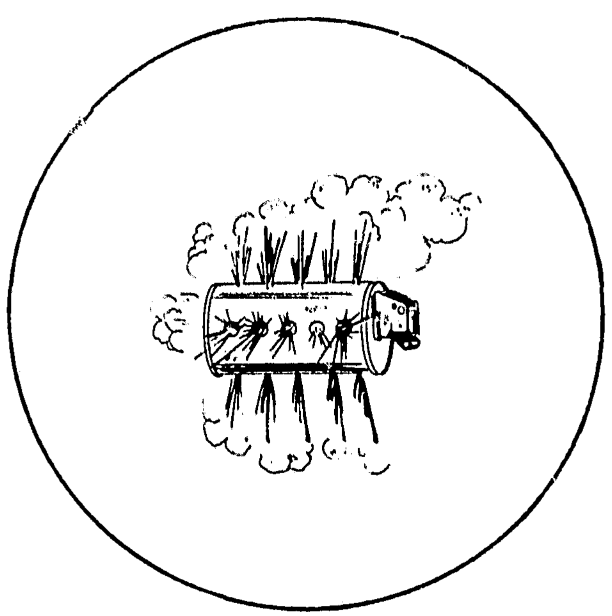
Foreword

This manual represents the best information available to the IACP as of 1 July 1969. It updates and revises all previous *Riot Control Agent Information Series* publications, which should be corrected or destroyed.

To keep this publication current it should be cut as indicated inside the back cover and maintained in a standard three-ring binder so that additional revisions and additions can be added as they become available.

Suggestions for the improvement of this manual are welcome and may be submitted to the IACP or to the Project Manager on Violence, Law Enforcement Assistance Administration, U. S. Department of Justice, 633 Indiana Avenue, N.W., Washington, D. C. 20530.

THOMPSON S. CROCKETT



On Eggs and Omelets

When in the normal course of events a hen lays an egg, there is little need and even less demand for an explanation. On the other hand, when a rooster delivers a chartreuse alligator egg there would seem to be some cause for elaboration. In the case of this publication, the explanation is simple. It is the result of the combined knowledge and experience of hundreds of police officers, researchers, and representatives of the chemical munitions industry who were willing to share their insights with the IACP Chemical Agents Program team.

While they can hardly be held responsible for the final nature of the omelet, grateful acknowledgement is extended to the following people who contributed above and beyond the call of duty during the incubation period:

J. Philip Kruse, *Assistant to the Chief of Police, Cleveland, Ohio,* for his able assistance early in the project and especially his research on protective masks.

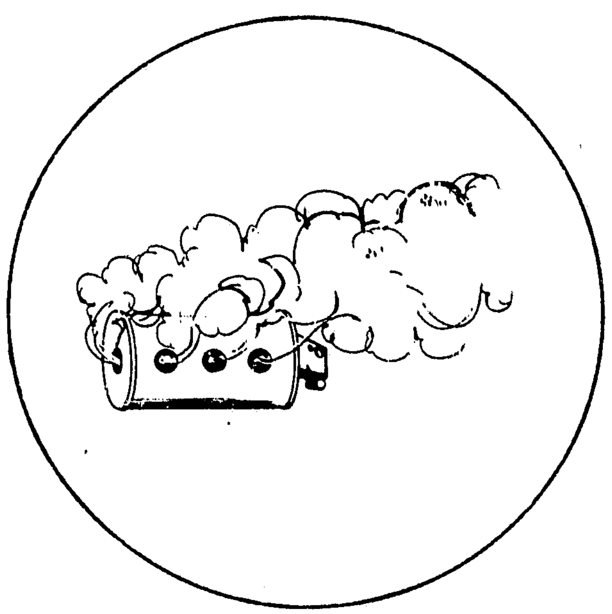
Neil C. Chamelin *of the Florida Institute for Law Enforcement,* St. Petersburg Junior College, and his Stetson University research team for their study of the civil aspects of the use of chemical agents.

Lieutenant Colonel Paul M. Adams *of the United States Army, Military Police,* for his interest and cooperation.

Alan Litman of G.O.E.C. and Richard E. Reinnagel of Cornell Aeronautical Laboratory deserve special acknowledgement for the technical assistance that they were always ready to contribute to the Chemical Agents Program.

By their patience and understanding during the production phase, Bill Brower, our artist, and Bill Marshall of Corporate Press made a substantial contribution. Miss Michele Lydon of the IACP staff worked tirelessly on the manuscript and shed more than her share of tears during the field evaluation sessions.

Table of Contents



RAPID CONTENT LOCATOR

CHAPTER ONE

Chemical Agent Policy and Procedure

The purpose of this manual is to provide law enforcement personnel with the information that they need to make sound decisions relating to the use of chemical agents in the achievement of police objectives. At the executive level such decisions involve the formulation of policy and procedure that will provide the basis for all departmental chemical operations.

It is often said that *policy* decides *what* is to be done and *procedure* directs *how* it is to be accomplished. There is no area of police activity in which policy and procedure are more important than in those situations involving the use of force. Since chemical munitions, like firearms, are essentially devices for the application of force, the development of guidelines for their employment is a command responsibility as well as an operational necessity.

For the police administrator, the issue is never whether or not his organization will have a policy in relation to the use of chemical agents, but only *who* will establish such policy. It is a fact of life that in the absence of direction from above, each officer will establish his own policy and his decision may or may not reflect the desire of the chief executive, who is ultimately held responsible for the consequences of whatever action is taken by operational personnel. Beyond the question of control, there is also a clear obligation on the part of the police leadership to provide guidance for officers expected to function under difficult field conditions. Thus, it is both unwise *and* unfair to permit operational personnel to carry out their responsibilities in what amounts to policy vacuum.

POLICY FORMULATION

Policy formulation is decision making and decision making involves, for the most part, the selection of a particular alternative from among the various choices available. In the case of chemical agents, each of the following major policy areas should be considered and a decision reached as to the most desirable course of action. In every area alternatives are available and the task of the policy-maker is to narrow down the many possibilities to a single actuality.

- What should be the underlying philosophy behind the use of chemical agents?

Necessary force becomes excessive force at that point where the violence involved becomes greater than that required to prevent or control specific kinds of unlawful behavior. In any event, police use of force becomes excessive at the point where its purpose ceases to become restraint or control and moves into the realm of punishment. By choice of agents, procedures, and tactics, a law enforcement organization will reflect a basic attitude toward the use of chemical agents that is either punitive or non-punitive in nature. Put another way, when an agent or procedure is selected that inflicts more pain or discomfort than necessary to obtain the immediate objective of restraint or control. such a choice is usually motivated, either consciously or unconsciously, by a desire to achieve punitive objectives.

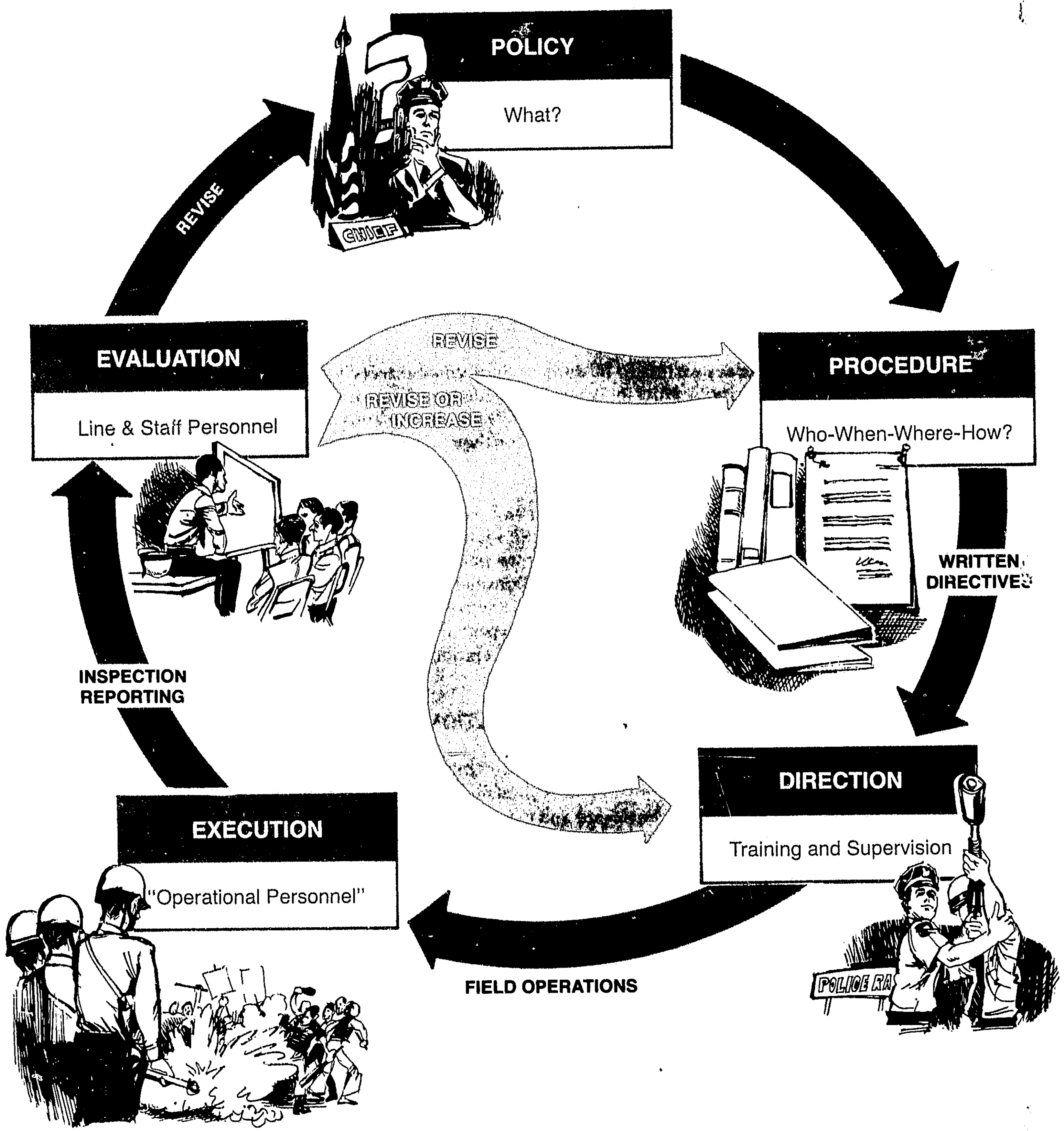


Figure 1 — The Policy/Procedure Cycle

- To what level of command, supervision or execution should the authority to employ chemical agents be delegated?

Decisions regarding the delegation of authority must always be made individually by each police executive after consideration of such variables as the quality of subordinates, the level of training, the importance of immediate response, and the nature of the chemical weapons involved.

Generally, however, some delegation of authority will be necessary to cover the use of chemical agents in at least three separate and very different tactical situations; routine self-defense, barricaded criminals, and crowd or mob control. In the case of individual chemical weapons, such as the aerosol irritant projectors, which are used primarily for self-defense, the authority to decide, within established guidelines, when and where such devices are to be employed must clearly be delegated to each officer carrying the chemical weapon.

Operations against barricaded criminals occur under such a wide range of conditions that a decision to employ chemical agents can only be made by the officer in charge at the scene. This officer should have the authority to employ chemicals in accordance with his evaluation of the situation and his understanding of chemical agent performance.

The decision to use chemical agents to disperse disorderly or riotous groups is an extremely difficult one to make. Employed at the right moment, in the right amount, and properly exploited, chemical agents can be effective in preventing or limiting a civil disorder. Because of the many variables imposed by weather, target nature, munition characteristics, and tactical conditions, the decision to employ riot control agents can again only be made by the field commander. It is very unlikely that chemical agents can be employed with maximum effectiveness in civil disorder control when the authority for their employment has not been delegated to whoever is in charge at the civil disorder scene. When reliable communications between the field commander and the command post are assured, a decision to use chemicals may be cleared in advance. Such a requirement, however, does not alter the fact that the decision is made at the scene and usually only serves to complicate command at a critical point in disorder control operations.

- What agents should be employed?

The chemical agents currently available for police use have different characteristics. What agents should be employed in what situations? The present choices in riot control agents include CN, CS, DM and smoke. In the aerosol irritant projectors CN, CS, and oleoresin capsicum are available in a wide range of formulations that vary considerably in their effectiveness and potential for injury.

- Where will chemical munitions and protective masks be stored?

Chemical munitions and masks stored at a central location may prove difficult to transport quickly during an emergency. Decentralization of prestocks in precinct or district stations may distribute available resources too thinly and provide even more difficult transportation problems should the emergency arise in a distant area of the city. Should munitions and masks be carried in patrol, supervisory, or command vehicles?

- What restrictions should be placed on the use of chemicals?

For example, in what locations or situations, if any, will the use of chemical munitions be restricted or prohibited? The use of heavy concentrations of agent in the vicinity of schools, hospitals, or high speed expressways may produce greater than normal risks. Should this be covered by specific policy or left to the discretion of field commanders? What kind of public announcement should precede the use of agent against crowds? Should special rescue or fire equipment be present before chemical operations are initiated against barricaded criminals? Will chemicals be used against barricaded criminals holding hostages?

- What reporting requirements should be established in connection with the use of chemicals?

Some feedback of information is necessary to permit control and evaluation of chemical operations. The larger the law enforcement organization, the greater the need for a formal information system to provide policy-making personnel with the outcome of street operations. While operating personnel often have an unfortunate tendency to regard reporting requirements as an effort to second guess their judgment, the real value of such a system lies in its use to detect training needs, identify faulty procedures, and predict potential problems before they can cause serious difficulties.

STAFF ASSISTANCE

The average police administrator will probably require assistance in resolving some of the more complex policy issues surrounding the use of chemical agents. In the large department, a planning and research unit is usually available to perform this function and in smaller agencies such a study can be assigned to a competent staff or line officer. However, the rapid escalation of non-lethal chemical agent technology suggests that police agencies of all sizes would be wise to consider the appointment of a chemical agent officer to provide staff assistance to command and operational personnel in the area of chemical munitions employment.

Even when a technically qualified officer is not available within the department, it is still desirable to select and appoint an intelligent, interested individual as chemical agent officer. By reviewing the material released under the Department of Justice/IACP Chemical Agents Program and studying other available documents, the newly appointed chemical agent officer can quickly begin to build a background that will enable him to render valuable assistance in an area that becomes more technical as each week goes by. Figure 2, a special order appointing a chemical weapons officer, suggests the kind of responsibilities that could be assigned to a chemical agent staff specialist.

For assistance with specific chemical agent policy or procedural problems, the police planner can frequently utilize outside resources. The Federal Bureau of Investigation, The International Association of Chiefs of Police, and local national guard officials are usually willing to provide information or assistance within their area of competency. Chemical munitions manufacturers are also able and willing to provide help in some areas, although their commercial involvement may preclude a fully objective point of view in some subject areas.

FROM DECISION TO EXECUTION

Once policy decisions have been reached, detailed guidelines must be developed to inform those personnel involved of the desired method of carrying out the intent of the policy statement. Whether these guidelines are called procedures, orders, or known by some other title; they are essentially a set of instructions describing how a specific objective is to be achieved.

Figure 3 provides an example of a field procedure covering the use of aerosol irritant projectors. In this case, the policy position being implemented is specifically stated in part B. An attempt has been made to anticipate and answer questions that may arise in normal operations. Although the exact format of the dissemination document may vary from department to department, it should attempt to provide clear and concise answers to the questions Who, What, When, Where, Why, and How.

When written procedures have been developed, the next step is to insure that they are fully understood by those charged with their execution and supervision. This is normally achieved by furnishing a copy of the written directive to all personnel and then following up with appropriate training at the roll-call, recruit, and supervisory levels. Ideally, new procedures would be introduced first to supervisory personnel and then disseminated to the level of execution. In this way, supervisors will be in a better position to answer the questions of subordinates and will be more likely to take a positive attitude in implementing new practices.

When new procedures have become a part of police operations there remains a continuing requirement for evaluation to determine if desired objectives are being achieved. By effective inspection and reporting of field operations it is possible to identify the need for revision of policy, procedure, training, or supervisory techniques. Only constant and vigorous review of street experience by staff and operational personnel will make possible an effective departmental chemical agent program.

MULTNOMAH COUNTY SHERIFF

DEPARTMENT of PUBLIC SAFETY
SPECIAL ORDER

68-150

19 December 1968

SUBJECT: CHEMICAL WEAPONS OFFICER

EFFECTIVE: IMMEDIATELY

I. PURPOSE:

The increased emphasis on the use of chemical weapons by police officers and the great diversity of such weapons, which are now or will soon become available, makes it necessary to appoint a single person in the Department to become expert in such matters. Information on chemical weapons will be relayed to the Chemical Weapons Officer, as will any information of their use, malfunction, etc. The Chemical Weapons Officer will report monthly, in writing, to the Sheriff by the 10th of each month on his activities, including comments on new developments, training, and the Department's chemical weapons experience and capabilities.

II. RESPONSIBILITIES:

Sergeant James Thacker, in addition to his other duties, is appointed Chemical Weapons Officer for the Department. He will be responsible for the following:

A. Familiarity with all available material on chemical weapons and their use.

B. Evaluation of all Department, and other, available chemical weapons and their use.

C. The conduct of training programs for the Emergency Team and the remainder of the Department on chemical weapons and their use.

D. Assisting the Emergency Incident Staff as a special advisor on chemical weapons.

E. Advising the Sheriff and other Department members on chemical weapons matters.

James C. Holzman

SHERIFF JAMES C. HOLZMAN
DIRECTOR OF PUBLIC SAFETY

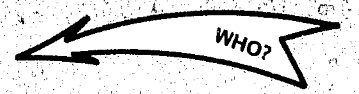
DISTRIBUTION:
All Units
E Manual – Directives Section

FIGURE 2 – CHEMICAL WEAPONS OFFICER SPECIAL ORDER

PROCEDURE NUMBER ______

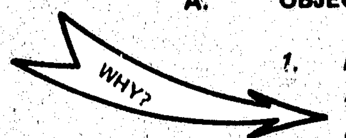
Field Operations and Enforcement

TO: ALL MEMBERS



RE: AEROSOL IRRITANT PROJECTORS

A. OBJECTIVES

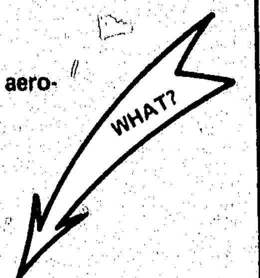


1. *Departmental*

   To assure the public maximum personal safety and convenience by providing protection and assistance.

2. *This Order*

   To establish policy and procedures for the use of chemical agents in aerosol irritant dispensers by Departmental members.



B. POLICY

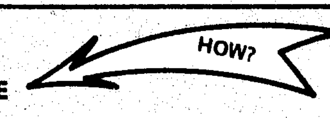
1. Members may use the aerosol device furnished by the Department as a defensive weapon in accordance with this order.
2. The use of chemical agent shall be considered an alternate action to the use of the baton under appropriate circumstances and is not intended as a replacement for the baton or approved firearms.
3. Projectors shall not be carried during off-duty hours unless prior approval is obtained from the appropriate Commander.

C. GENERAL

1. Chemical agent projectors are intended for use in those cases wherein the member is attempting to subdue an attacker or a violently resisting suspect or under other circumstances, within the rule of law, which permits the lawful and necessary use of force and which is best accomplished by the use of a chemical weapon.
2. Projectors shall not be used indiscriminately or in anticipation against mere threats of violence or resistance.
3. Chemical agents shall not be applied to any subject once he is secured and properly in custody.
4. The projector shall be carried in a holster on the belt as specified in the Uniform Manual.

FIGURE 3 – PROCEDURE FOR USE OF AEROSOL IRRITANT PROJECTORS

D. PROCEDURES FOR USE



1. Chemical agent furnished under this order is manufactured in an aerosol-type canister and is operable by depressing a valve on the top of the canister.
2. The application of agent to subjects shall normally be from a range of three to eighteen feet. Use at lesser distances:
   a. Renders the officer vulnerable to losing the projector.
   b. Increases the chance of the member becoming contaminated.
   c. Increases the severity and duration of effects to the subject.
3. The duration of the application of chemical agent shall be limited to the absolute minimum required to effectively control the subject. Normally, this will be a one-second application. In no case should more than three one-second bursts be fired directly into the face of a subject unless the officer is in immediate danger of serious injury.
4. Chemical agent is not recommended for use against subjects who confine themselves in closed vehicles and refuse to emerge. As a last resort, chemical agent may be used if necessary to prevent injury to an officer or the subject. Removal from the vehicle shall be accomplished as quickly as possible after using the chemical projector.

5. Subjects upon whom chemical agent is used must have apparent signs of being alert and in possession of their normal protective reflexes such as blinking, eye closure, breath holding, and turning away from the applied stream.
6. The projector will not be employed in the immediate vicinity of infants, since their respiratory systems are extremely sensitive to all kinds of vapors.
7. The aerosol irritant projector may be used in riots, civil disorders, and other emergency conditions only with the approval of the Operation Commander.

E. PROCEDURES AFTER USE

1. Subjects in custody to which a chemical agent has been applied shall be accorded first aid within 30 minutes from time of contamination. Applying *cool*, clear water to the contaminated area is considered adequate first aid treatment.
   a. First aid shall be administered at the scene, or as close thereto as possible, whenever the circumstances permit.
   b. Appropriate first aid locations shall not be bypassed merely because a detention facility is reachable within the 30-minute time span *unless* the safety of the officer or subject would be jeopardized by remaining at or near the scene.
   c. Absorption of chemical agent into the clothing can cause contamination of normally unexposed areas and should be considered as a condition requiring treatment.
   d. Salves, creams, ointments, or warm water should not be applied to contaminated areas because these may retard sublimination of the agent or increase skin absorption, thereby increasing local irritation.

2. In cases where first aid treatment fails to grant relief prior to commencing the booking process, medical care shall be secured.

3. In each case where a subject in custody has been subdued by chemical agent, such fact shall be noted on the booking sheet and called to the attention of the jailer or booking officer.

4. Members contaminated from using chemicals to the extent that normal physical functions are impaired shall receive the treatment described above. Appropriate Industrial Injury forms shall be submitted.

F. REPORTING

1. Standard Form___, Accident Report (Other Than Motor Vehicles) shall be completed for each subject on whom a chemical agent is applied.

a. The Departmental Reporting Manual shall govern the preparation and distribution of the form.

b. The space on the form marked, "Description of Property Involved", should include:

(1) The words, "Aerosol Chemical Agent".

(2) The time first aid treatment was provided as required by E.1. above.

c. When projectors are used under circumstances which do not permit identification of the subjects involved and, therefore, no treatment or arrest results, the following procedure shall apply:

(1) Under normal command operations a memorandum report of the incident shall be submitted by the member to his commander.

2. The Operation Commander shall include any information concerning use of aerosol irritant projectors as part of the summary report required following civil disorder operation.

G. DISTRIBUTION OF AEROSOL IRRITANT PROJECTORS

Projectors and holsters shall be obtained through requisition procedures contained in Chapter_____of the Administrative Procedures Manual.

CHAPTER TWO

Introduction to Police Chemical Agents

Chemical agents have been used by the police to subdue criminal and riotous individuals or groups for many years. The police of Paris are credited with the modern development of the concept in the year 1912 when "hand bombs" filled with an early tear gas were used to incapacitate gangs of criminals that were presenting a serious threat to life and property in the French capitol. From this law enforcement origin grew the subsequent development of military chemical warfare which began with tear gas and quickly escalated to the dreaded lethal and disabling gases of World War I and the modern era.

The ethyl bromacetate used by the Paris police in their "hand bombs" and contemporary "tear gases" are members of a family of chemical compounds that are known as lacrimators because they produce a severe weeping or tearing of the eyes. Ethyl bromacetate, a relatively volatile liquid which is effective in very low concentrations, produced a vapor or gas that proved to be a very effective lacrimator, giving rise to the term "tear gas". The term tear gas has remained in popular use, although modern riot-control agents such as CS are dry powders which have a relatively low volatility. The modern agent is dispersed as a fine dust cloud from bulk dispensers or bursting containers as recondensed particles from burning mixtures of agent and an appropriate fuel, or as liquid aerosols.

MODERN RIOT CONTROL AGENTS

After years of experimentation and research with a wide range of chemical compounds, three separate agents are currently available to law enforcement agencies for use in riot control and the capture of armed, barricaded, criminals. Two of these agents, designated CN and CS, are lacrimators and the third, DM, is a nauseating or sickening agent, which is not recommended for general law enforcement use. While these agents all produce temporary irritation or disabling physiological effects when they come into contact with the eyes or are inhaled in sufficient concentrations, they each have individual characteristics which govern their use in specific situations.

CN AGENT

CN or Chloroacetophenone, which was discovered by a German chemist in 1869, is currently the "tear gas" most widely used by law enforcement agencies throughout the world. CN produces a characteristic apple blossom odor under normal conditions and is released as a particulate cloud, or dissolved in a liquid and released as a liquid aerosol.

The CN agent quickly irritates the upper respiratory passages and eyes, causing a heavy flow of tears within seconds after exposure. In high concentrations CN is irritating to the skin and can cause a burning, itching sensation on moist parts of the body. In some individuals, CN agent may produce nausea, especially when experienced in heavy concentrations.

CN agent is usually dispensed by burning or blast dispersion in hand grenade and projectile munitions. It is also being disseminated in the newly developed fogging devices and is the active component in most of the hand-held aerosol irritant projectors discussed in Chapter 5.

CN, like other agents, must be used with discretion, especially when the agent is introduced into small rooms or other confined areas.

DM AGENT

DM or Diphenylaminechloroarsine was discovered in 1918 by the American Chemical Warfare Service and called "Adamsite" in honor of its developer, Major Roger Adams. DM is a nauseating agent that produces extreme discomfort and sickness. The DM produces a yellow particulate cloud that has a "smoky" odor which rapidly disappears as the agent affects the sense of smell. Since DM requires several minutes to reach full effect, it is sometimes mixed with CN to produce a more immediate response.

Within a minute or two following exposure, DM produces a burning sensation of the nose and throat often followed by sneezing and coughing. When the full reaction point is reached, the individual experiences severe headaches, profuse watery nasal discharge, acute pains in the nose, sinus and chest and ultimately nausea and vomiting. During the final stages, the DM victim may experience mental depression and sensory disturbance.

The physiological reaction to DM is extremely severe, with incapacitation sometimes lasting several hours and effects possibly persisting for several days. Lethal concentrations are within the range of possibility and injuries are likely when heavy concentrations are employed. The Armed Forces have directed their personnel not to use DM in any riot control operation where deaths are not acceptable and the Department of the Army does not even discuss the use of DM in its field manual covering the control of civil disturbances and disorders.

DM is currently stocked in small quantities by only a limited number of police departments in the United States. *It is not recommended for law enforcement use* under any but the most extreme conditions.

CS AGENT

CS or orthochlorbenzalmalononitrile, the newest of the riot control agents, was first developed in 1928 by two scientists, B. B. Carson and R. W. Stoughton, whose last initials are used to identify the compound. CS came to the attention of law enforcement officials in this country as a result of its use by the British during the civil disorders on Cyprus in 1961.

After an exhaustive testing program, the U. S. Army adopted CS as its standard riot control agent. Existing CN stocks were replaced with the newer CS agent and today military units assisting local police in the control of disorders will be equipped exclusively with CS munitions.

Tests conducted by physicians and toxicologists have indicated that CS has a safety factor which makes the probability extremely low that lasting effects or death could result from its proper use in riot control situations. Limited laboratory experiments with animals and humans have produced no significant ill effects from the CS agent, even in persons fifty years of age with medical histories of allergies, hypertension, jaundice or hepatitis.

It should be pointed out, however, that "safety" is a relative term when used in connection with riot control agents of any kind and there is always a possibility of injury or death under unusual circumstances or when agents are improperly employed. Assurances from commercial and military sources regarding the comparative safety of CS should not be permitted to obscure the fact that, like any other agent, CS must be used with discretion.

Whether or not police officials elect to utilize CS in their current chemical weapon inventory, all national guard and federal troops committed to disorder control duty will be equipped with CS and consequently local law enforcement officers should be familiar with the characteristics of the agent.

CS is a white powder that can be dispersed in several ways: a) in prepacked containers such as hand thrown grenades, b) by small projectiles, or c) by a spray from a pressurized container such as a properly modified dry chemical fire extinguisher. It produces immediate distress on contact with the eyes, the respiratory tract, and the skin, and will render the recipient incapable of purposeful aggressiveness while in contact with it and for about 10 to 20 minutes after he has been exposed to fresh air. Very heavy concentrations may produce nausea, vomiting, psychological depression, and extended recovery periods.

Although the symptoms produced by CS vary to some degree in relation to the concentration and dose, it is generally agreed that, compared to CN, equal amounts of CS agent produce more immediate and severe reactions. This is especially true of internal symptoms involving the respiratory system.

CRITERIA FOR SELECTION OF A RIOT CONTROL AGENT

Most authorities agree that an acceptable riot control agent should possess certain characteristics based upon the requirements of civilian law enforcement service. Although none of the existing agents fully satisfy the criteria listed below, each of the seven characteristics should be taken into consideration in the selection of a chemical agent for police use.

1. *Safety* – The primary criteria in agent selection is safety. Although chemical agent "safety" involves several dimensions which are discussed in greater detail later in this publication, the minimum criteria is that the agent be non-lethal in any concentration likely to be developed in police application.

2. *Effectiveness* – The agent should:

   a. Produce *rapid physiological action*.

   b. Produce desired effects in low concentrations, somewhere in the range of a few milligrams per cubic meter of air.

   c. Permit *rapid recovery* without lasting effects when subject is removed from the contaminated area.

3. *Deliverability* – The agent must be deliverable in sufficient concentrations by delivery systems adaptable to police requirements arising from the nature of field operations.

4. *Non-Persistency* – The agent must be temporary in duration of its effectiveness and should not present major decontamination problems. Persistency is a product of several factors including the nature of the agent, method of dissemination, weather, and the area contaminated.

5. *Stability* – The agent should be stable over wide ranges of temperature variation and storage conditions. It must be compatible with selected delivery systems.

6. *Acceptability* – The use of the agent must be tolerated by the general public. A negative response on the part of most of the citizens in a community to a specific agent may well offset any advantages that the agent might otherwise offer.

7. *Cost Effectiveness* – The total cost of the delivered agent must be proportionate to its effectiveness and competitive with acceptable alternatives. In addition, the cost of chemical munitions must be reasonable in relation to police resources.

[redacted]

CHARACTERISTIC	CS
Composition	[redacted]
Odor	[redacted]
Persistency (in open)	[redacted]
Minimum effective protection.	[redacted]
Physiological action	[redacted]
Time required for maximum effort.	[redacted]
First aid.	[redacted]
Type of munitions.	[redacted]
Mechanically dispersable.	[redacted]

*FROM: DEPARTMENT OF THE ARMY FIELD MANUAL FM-19-15, MARCH 1968, WITH UPDATED FIRST AID SECTION.

CHEMICAL AGENT TERMINOLOGY

In order to understand something about chemical agents and how they are evaluated, law enforcement officials should be familiar with several basic terms and concepts that are commonly employed in describing the physical and chemical properties of such agents.

Aerosol – a liquid or solid, not vaporized, but divided into particles small enough to float in the air for extended periods of time. Examples of common aerosols are mist, fog, and smoke. (A vapor is the gaseous form of any substance that is normally a solid or a liquid.)

Concentration – the amount of chemical agent present in a unit volume of air. Usually expressed in milligrams per cubic meter of air. (mg/m^3)

Dosage or Ct – the concentration (C) of chemical agent in the air multiplied by the time (t) the concentration remains. Dosage is usually expressed as $mg\text{-}min/m^3$.

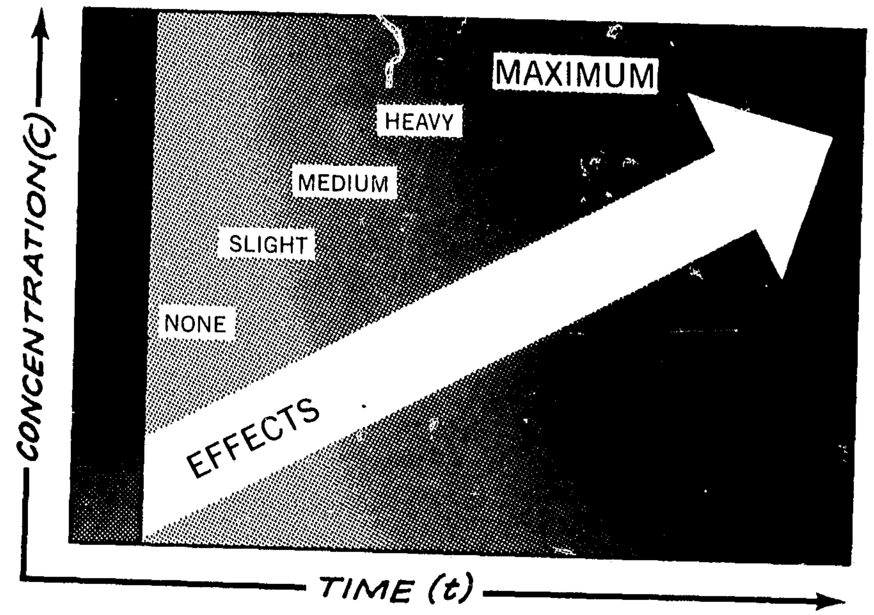


FIGURE 1 – THE Ct RELATIONSHIP FOR CHEMICAL AGENTS

Since dosage is a combination of concentration and time, the same effects with riot control agents can be achieved by an exposure to a high concentration for a short period of time or to a lower concentration for a longer period of time. This general relationship is illustrated in Figure 1.

From a practical standpoint this means that approximately the same effects would be produced by 30 seconds exposure to the agent released by two grenades as would be produced by 60 seconds exposure to a single grenade release. Put another way, the same range of effects can generally be produced by *either* heavy concentration or prolonged exposure.[1]

[1]The validity of this relationship over wide ranges of time/concentration has not been established, but the principle is considered reliable under normal operational conditions.

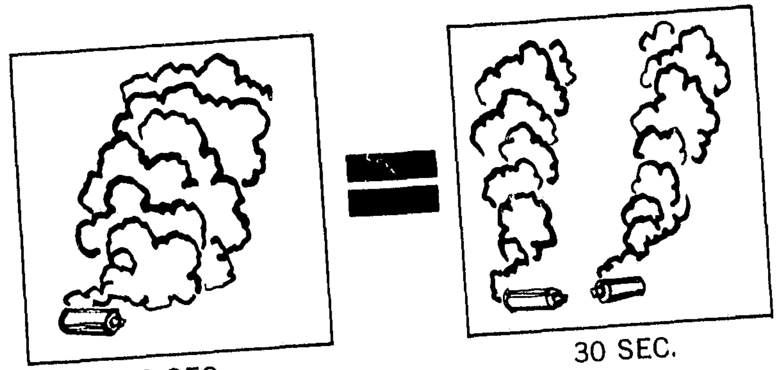


FIGURE 2 – THE PRACTICAL CONSEQUENCE OF THE Ct RELATIONSHIP FOR RIOT AGENTS

Median Incapacitating Dosage (ICt_{50}) – The incapacitating dosage of a chemical agent is usually expressed as the amount of inhaled vapor or aerosol which is sufficient to incapacitate 50 percent of exposed personnel. For example, the ICt_{50} value of CN is reported as about 20 mg-min/m^3.

The term ICt_{50} is an appropriate term with respect to material that acts systemically within the body to produce its effect, but in the case of riot control agents, whose effect is not systemic and is measured in fractions of a minute, the more desirable term is IC_{50}. IC_{50} is defined as that amount of agent which will be intolerable in one minute to 50% of a population. The exact concentration depends upon the population's degree of motivation to resist, thus the IC_{50} is listed as a range of concentrations and the average around which most of the population clusters. The IC_{50} is expressed only as milligrams per cubic meter (mg/m^3).

Median Lethal Dosage (LCt_{50}) – The LCt_{50} of a chemical agent is the concentration multiplied by the time of exposure that is lethal to 50 percent of exposed personnel. The unit used to express LCt_{50} is milligram minutes per cubic meter. Again, using CN as an example, the LCt_{50} value is estimated as about 14,000 mg-min/m^3.

It is important to note that median dosages are values established primarily for comparison of the *relative effects* of chemical agents. Obviously, law enforcement officials are more concerned about the absolute minimum risk level than with the standard LCt_{50}, which deals with the concentration sufficient to kill at least 50 percent of the human subjects exposed to the agent.

Unfortunately, the minimum risk data on chemical agents is difficult to obtain. Even available LCt_{50} values, which are estimates based upon laboratory tests on animals, are highly vulnerable to challenge and are the subject of considerable disagreement among chemical agent researchers and manufacturers.

Safety Factor – the ratio between the lethal and the incapacitating dose of a particular agent. (LCt_{50}/ICt_{50}) Returning to our example, CN, the LCt_{50} 14,000/ICt_{50} 20 results in a safety factor of 700. In other words, it would take 700 times the incapacitating dose to produce a lethal dose in 50% of the exposed population.

Again it is suggested that the minimum lethal dosage is of more concern to the police personnel planning chemical agent operations. However, such data are not currently available.

Particle Size – The size of the very small particles of chemical agent in the cloud are measured in terms of MICRONS (μ). A micron is 1/25,000 of an inch and those particles smaller than one micron in diameter are referred to as sub-micron particles. As a rule, agent dissemination by burning produces a much smaller particle than that produced by blast dispersal.

The physiological effectiveness of skin and respiratory aerosol dosages of riot control agents are influenced by particle size as well as by time and concentration, since retention by the lungs and contact with the skin are functions of particle size.

Particle size is also an important consideration in delivery of agents, since heavier particles tend to "fall out" of the agent cloud while smaller particles remain airborne for longer periods. Particles larger than 30 microns in size tend to drop out of the air very rapidly and are therefore ineffective.

The optimum particle size or size range is a compromise based upon agent impaction characteristics, agent cloud travel, inhalation-retention, and infiltration. It has been suggested that a particle size range of 0.5 micron (cigarette smoke) to 5 microns (dusting grade corn starch) is acceptable. Burning grenades generally produce particles in the size range of 0.5 to 1 micron. In all other systems in use today, except when the agent is in solution, the particle size depends upon the size of the particle as the agent is manufactured, the additive used to reduce agglomeration, and the energy available (for example, the amount of explosive) to disperse the agent which is in the form of a dry powder in the munition. In most of the blast devices currently available, the energy is kept low to minimize hazard and the effective particle size tends to be somewhat larger than optimum.

While the larger particle size may not be optimum for general use conditions, it may still be adequate for dispersal of personnel. In addition, the larger particle size should settle to the ground more rapidly, thus localizing its effect and restricting contamination to smaller areas and minimizing agent infiltration into adjacent buildings.

Persistency – an expression of the duration of effectiveness of a chemical agent. Persistency is of particular interest in relation to riot control agents in the matter of contamination of buildings and vehicles.

RISK EVALUATION

At best, "safety" is a relative term when applied to the evaluation of chemical agents. In fact, in the interest of both accuracy and clarity, the term "safety" (defined as "freedom from danger") should be replaced in this context by the term "risk", which is defined as exposure to danger. The question for police officials then becomes: "What risk is involved in our use of this agent? " and not the virtually unanswerable query "Is this agent safe? "

Figure 3 contains a summary of data comparing the major characteristics of CN and CS agents. The claim of the relative safety of CS is based upon the information in the section of the chart entitled "Estimated Dosages." The major source of estimates of this kind is the U.S. Army, which generally acts upon the recommendations of the Human Estimates Committee, Research Laboratories, Edgewood Arsenal, Maryland. At the present time research is under way at Edgewood Arsenal that may eventually result in a revised recommendation by the Human Estimates Committee. By redefining the safety factor as LCt_{50}/IC_{50}, instead of LCt_{50}/ICt_{50}, and substituting the new estimates now under study, the future estimated dosages may establish an even greater safety factor differential between CS and CN.

In any event, it is clear that the risk of developing a lethal concentration is less with CS than with CN and it is equally evident that CS is effective in lower concentrations and is also faster acting. On the other hand, it is still true that CS is a potent agent with effects that exceed those of the traditional CN. Obviously, CS must be employed with greater discretion than that which has characterized past uses of CN if police are to avoid legitimate criticism and opposition to the introduction of CS into civilian police operations.

It is also important to bear in mind that the possibility of death through the development of a lethal concentration is only one of the risks involved in the use of chemical agents. For example, regardless of the safety factors or LCt_{50}'s involved, if an agent produces a high incidence of panic-related unpredictable behavior or causes temporary loss of consciousness in certain types of personnel, it could

FIGURE 3 – CHARACTERISTICS OF CN AND CS AGENTS

		CN	CS
PHYSIOLOGICAL ACTION	EYES	Burning sensation Heavy flow of tears	Burning sensation Heavy flow of tears Involuntary closing of eyes
	SKIN	Stinging or burning sensation on moist areas Blister from very heavy concentration	Stinging or burning sensation on moist areas Blister of exposed skin from heavy concentration (at Ct 14,000) Second degree burns delayed 14 - 16 hours after exposure
	NOSE	Irritation-burning sensation	Irritation-burning sensation Nasal discharge
	MOUTH	Salivation	Salivation
	CHEST	None reported	Irritation-burning sensation Coughing Tightness in chest Feeling of suffocation - accompanied by *panic*
	GASTRO-INTESTINAL SYSTEM	Nausea in very high concentration or prolonged exposure	Nausea, vomiting-especially in heavy concentration or prolonged exposure
	CENTRAL NERVOUS SYSTEM	Headache	Headache Dizziness or swimming of head. *Inability to take effective concerted action* while exposed and five to ten minutes after. Sense of physical ill-being (malaise) up to 24 hours for some subjects *Prostration* up to several minutes for some subjects.
ESTIMATED DOSAGE	Median Lethal Dosage (LCt_{50})	14,000 mg-min/m^3	25,000 mg-min/m^3
	Median Incapacitating (ICt_{50})	20 mg-min/m^3	10-20 mg-min/m^3
	Safety Factor (LCt_{50}/ ICt_{50})	700	1250-2500

present an unacceptable injury risk that would be entirely independent of any lethal potential. The fact that injury was sustained as a result of agent induced behavior rather than by the chemical itself does not diminish the risk considerations. In the same way, an agent that tended to produce severe, but not fatal, respiratory disorders might be unacceptable regardless of its relative safety factor. Thus, an agent's safety factor or LCt_{50} is only one of the risk factors that must be considered by law enforcement officials in the selection of a chemical agent for use in both civil disorders and routine police operations.

It happens that CS has been known to produce panic behavior and has in research experiments caused personnel with respiratory and heart disorder histories to lose consciousness for periods up to ten minutes. The extent to which these characteristics may or may not create problems under police field conditions can, in the final analysis, only be evaluated from actual experience. Unfortunately, non-military experience with CS has been limited. During the April 1968 disorders only Washington, D.C., Baltimore and Kansas City used chemical agents in any quantity and CS use was confined largely to Washington and Baltimore. Since that time, CS has been used extensively in connection with the Miami, Chicago and Berkeley disorders and during the "Poor Peoples" demonstrations in Washington, D.C. These applications have been studied closely and no major problems have developed from the use of CS. As time goes by and field experience accumulates, CS will build a performance record that will allow secondary risk evaluations of an even greater level of confidence.

Finally, it should be noted that safety or risk resides not only in the characteristics of the agent, but is equally a product of the way in which agents are delivered. Thus poorly trained officers or improperly designed delivery systems will increase whatever risk factors may be associated with a particular agent formulation.

EFFECTIVENESS CRITERIA

Experiments conducted by the military with volunteers exposed to CN and CS suggest that CS produces intolerable symptoms more quickly and in lower concentrations that CN. Figure 5 summarizes the results of these experiments. For example, in a concentration of 51 to 100 mg/m^3 of CS, 12 out of 12 subjects found the effects intolerable within 30 seconds, while in a similar concentration of CN all 24 subjects could remain in the test chamber for the 30-second period.

Information available at the present time indicates that persons subject to reasonable concentrations of both CN and CS recover within 5 to 20 minutes after removal from the contaminated atmosphere. However, the

CONCENTRATION RANGE (mg/m^3)	NUMBER OF MEN FINDING AGENT INTOLERABLE WITHIN 30 SECONDS	
	CN	CS
2 - 10	0/4	2/15
11 - 20	0/1	3/6
21 - 50	0/8	10/10
51 - 100	0/24	12/12
101 - 360	3/12	--
	NUMBER OF MEN FINDING AGENT INTOLERABLE WITHIN 120 SECONDS	
	CN	CS
2 - 10	0/4	6/15
11 - 20	1/1	5/6
21 - 50	2/8	10/10
51 - 100	3/24	12/12
101 - 360	9/12	--

FIGURE 4 – EFFECT OF CS AND CN ON HUMAN SUBJECTS

volume of information relative to recovery from chemical agents is not extensive, especially in cases where concentrations are heavy or exposure prolonged, and law enforcement personnel should be guided accordingly in their use of chemical agents in enclosed places or against persons who are unable to remove themselves from the contaminated area.

The significant difference between CN and CS is that an increasing dose of CN does not necessarily produce additional symptoms, whereas with CS, the type of symptoms and consequently the level of incapacitation does increase with dose.

PERSISTENCY

CN and CS agents remain airborne for relatively short periods of time, depending upon weather conditions, the particular delivery system employed, and the agent particle size. Both agents are sufficiently non-persistent for riot control use.

CN, being approximately 100 times more volatile than CS, may produce a vapor concentration which is itself incapacitating. However, in vaporizing (or to be more accurate, in subliming), the CN is being constantly dispersed into the air and hence its long-term persistence as a dry powder is much less than with CS. Based upon very preliminary testing, it appears that under normal conditions, a 10-micron particle of CN will completely sublime in less than 20 minutes. The time for total sublimation increases with particle size.

Experience to date suggests that, compared to CN, CS contamination is extremely difficult to remove. When used indoors, CS particles settle on floors, walks, ceilings, and merchandise or household furnishings where they remain for extended periods of time. Unless removed, these fine particles are reactivated and become airborne, producing CS symptoms, whenever the air in the contaminated area is disturbed.

Major industrial and research corporations are presently attempting to develop techniques that will provide more satisfactory decontamination and there is hope that improved agent delivery systems may reduce the severity of the contamination problem. Decontamination is discussed in greater detail in Chapter Seven.

STABILITY

Both CS and CN, as reflected in the technical summary in Figure 6, are stable over wide temperature ranges and are compatible with existing delivery systems. Both are also stable in storage in their original formulation. Storage problems associated with assembled munitions are discussed in Chapter Nine.

FIGURE 5 – PHYSICAL AND CHEMICAL PROPERTIES OF CS AND CN

	CN(CHLOROACETOPHENONE)	CS(O–CHLOROBENZALMALONONITRILE)
1. Formula	$C_6H_5COCH_2CL$	$CLC_6H_4CHC(CN)_2$
2. Molecular Weight	154.59	188.5
3. Density (Crystal)	$1.30 \frac{gm}{cm^3}$ at 20°C	$1.33 \frac{gm}{cm^3}$ at 25°C
4. Melting Point	54° – 55°C	93° – 95°C
5. Boiling Point	244° – 245°C	310° – 315°C
6. Volatility	$105 \frac{mg}{m^3}$ at 20°C	$0.7 \frac{mg}{m^3}$ at 25°C
7. Flash Point	High enough not to interfere with use of agent	197°C
8. Decomposition Temperature	Stable to boiling point	Thermal stability good
9. Rate of Hydrolysis	Not readily hydrolyzed	Not very rapidly hydrolyzed
10. Hydrolysis Products	Hydrogen chloride and hydroxymethylphenylketone	Initial ones: o-chlorobenzaldehyde and malononitrile anion
11. Stability in Storage	Stable	Stable
12. Latent Heat of Vaporization	98 calories/gm	96.5 calories/gm
13. Action on metals	Tarnishes steel slightly	Very slight action on steel
14. Odor	Like apple blossoms	Like pepper

CHAPTER THREE
Dissemination and Delivery Systems

Chemical agents are used by the police in riot control situations to cause people to behave in a desired manner. As a practical matter, this generally involves getting rioters and bystanders to leave a particular area or to abandon some form of unlawful activity. In the case of snipers, the agent is used to force the violator to leave a barricaded position in order to facilitate his capture. In any event, the chemical agent must be *delivered* to the target area and *disseminated* in sufficient quantity to produce the desired behavior, but in concentrations unlikely to produce permanent injury or undesirable reactions.

DISSEMINATION METHODS

All presently available dissemination methods begin with chemical agent in one of the following states:

(1) *Solid* – granulated agent combined with a pyrotechnic mixture.

(2) *Micropulverized* – agent reduced to an extremely fine powder or dust.

(3) *Liquid* – agent suspended in a liquid solvent.

The solid, micropulverized, or liquid chemical agent formulation is dispersed by one of the four basic dissemination methods employed by all of the currently available chemical munitions.

(1) *Expulsion* – the use of an explosive or other force to eject micropulverized chemical agent into the atmosphere.

(2) *Pyrotechnic* – the burning of granulated chemical agent and a pyrotechnic mix to vaporize the agent and release it as a submicron aerosol cloud.

(3) *Fog* the use of hot gases to vaporize a liquid agent formulation which is subsequently released as a fog cloud.

(4) *Liquid* – the use of an expelling force to project a liquid chemical agent formulation to a desired target.

EXPULSION DISSEMINATION

All dissemination methods that employ a force to expel and scatter a cloud of chemical agent can be called expulsion methods. Expulsion devices share a common characteristic in that they all require an extremely fine agent formulation that will provide particles small enough to remain airborne and drift with existing wind currents once they have been released from their containers. To provide such a formulation, the chemical agent is micropulverized during the manufacturing process and either mixed with, or coated on, very fine carrier materials such as silica aerogel or diatomite. The carrier material adds fluidity and helps to prevent the agent particles from caking together in the container prior to dispersal. In some cases, a synergistic carrier such as silicic anhydride is employed to produce a sneezing reaction that increases the total effect of the formulation. A mixture ratio of 5% carrier and 95% agent is employed in military munitions, but commercial products may range from a similar ratio down to a 50/50 mixture, depending upon the manufacturer.

While the micropulverized agent produces small airborne particles, ideally in the range of 1 to 10 microns,[1] their median size is considerably larger than the submicron particles produced by the burning or pyrotechnic method. This larger particle size accounts for the more persistent and irritating effects attributed to the micropulverized agent. The actual size of the aerosol cloud produced by expulsion of micropulverized agent is determined by the amount and formulation of the agent, the force employed, and prevailing weather conditions.

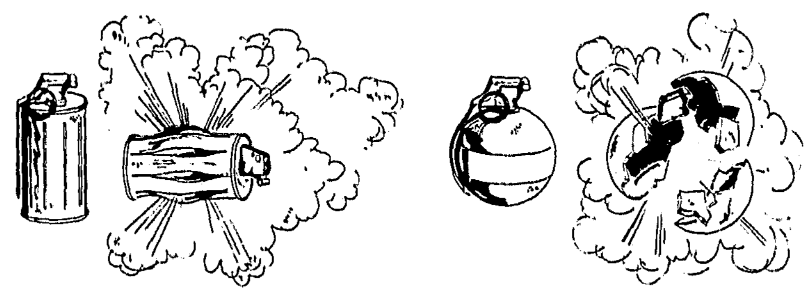


FIGURE 1 – EXPULSION DISSEMINATION
An explosive force ruptures or disintegrates a grenade or projectile body and scatters the micropulverized agent.

Grenades and projectiles that employ an explosive force to scatter a pulverized cloud of chemical agent are often referred to as explosive, bursting, instantaneous discharge, or blast dispersion munitions. All of these devices use an explosive force that either shatters the container, ruptures the container, or generates gases that propel the agent out of exit ports built into the munition body. Typical of the latter design is the new piston release technique which involves the use of a powder charge to activate a piston that literally pushes the agent out of an exit port located on the base of the grenade. The explosive force required to activate the piston is of such a low magnitude that the grenade can be hand held during release.

Cartridges that are designed to expel a cloud of micropulverized agent out of the muzzle of a standard or special purpose firearm are also classed as expulsion devices. The primer, and usually a booster charge, provide the explosive force necessary to drive the agent down the barrel of the weapon and into the atmosphere.

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1. A micron is a unit of measurement equivalent to 1/25,000 of an inch.

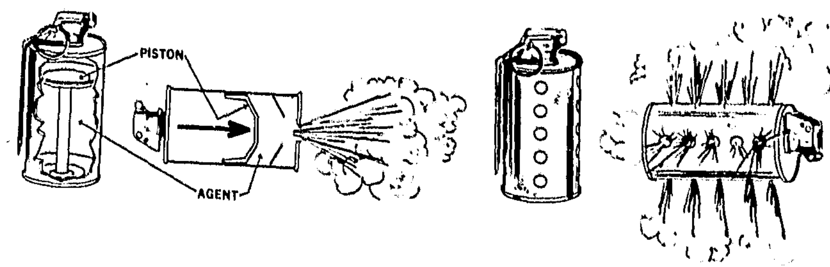


FIGURE 2 – EXPULSION DISSEMINATION
An explosive force provides energy to eject the micropulverized agent from exit ports built into the grenade body.

Expulsion dissemination is also accomplished through the use of pressurized dispensers, often referred to as bulk or mechanical dispensers, which utilize a cold gas such as compressed air or nitrogen to expel the micropulverized agent into the air. These dispensers are generally employed when a larger amount of agent or greater area coverage is required than can be obtained by the use of standard grenades or projectiles.

PYROTECHNIC DISSEMINATION

Pyrotechnic dissemination techniques that release the agent cloud through a burning process are also referred to as combustion, continuous discharge, or burning methods. This form of release involves combining the coarsely granulated chemical agent with a pyrotechnic substance and pressing the mixture into a cake that will burn upon ignition. The agent is released into the atmosphere along with clouds of smoke that are easily visible and serve to identify rather accurately the contaminated area and the direction of its movement. At the present time only grenades, projectiles, and the chemical wand employ pyrotechnic dissemination.

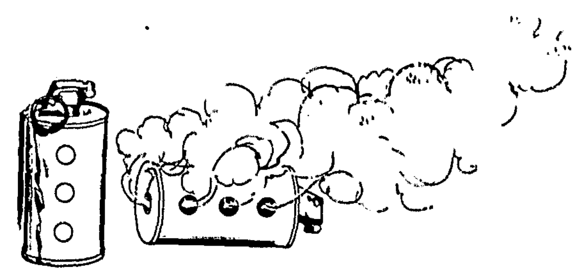


FIGURE 3 – PYROTECHNIC DISSEMINATION
An agent/fuel mixture is burned to release active agent and smoke cloud from exit ports on the grenade or projectile body.

A typical pyrotechnic agent/fuel mixture might contain about 40% chemical agent and 60% fuel. Again, however, ratios vary from manufacturer to manufacturer.

Once airborne, the vaporized agent recondenses as submicron particles which drift downwind until the concentration is diluted to the point of ineffectiveness. Again, the size and behavior of the agent cloud depends primarily upon the formulation and quantity of the mixture, the nature of prevailing weather conditions, and to a lesser extent the design of the munition.

FOG DISSEMINATION

Fog dissemination devices operate by rapidly vaporizing a high boiling point liquid agent formulation. This is accomplished by injecting the liquid agent into a hot gas flow and allowing the vaporized agent to contact the cooler ambient air where the agent condenses into a fog and ultimately into extremely small agent particles.

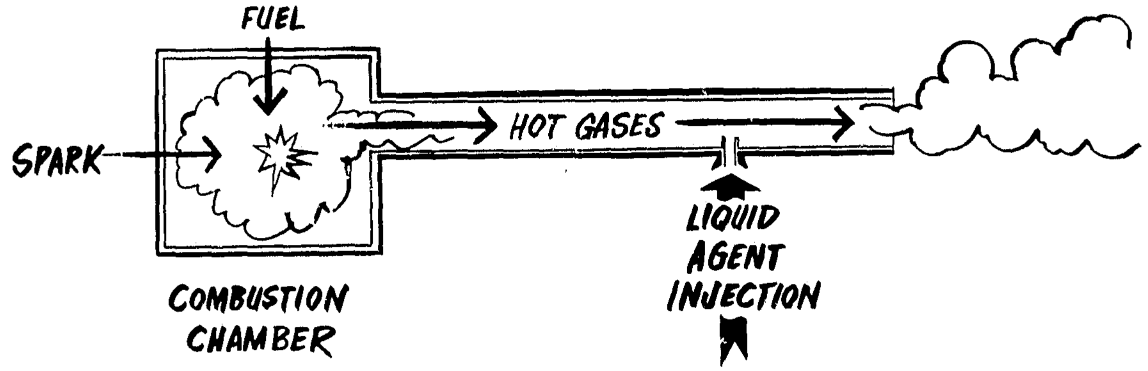


FIGURE 4 – FOG DISSEMINATION
A liquid chemical agent is vaporized by a hot gas flow and released as a fog cloud.

LIQUID DISSEMINATION

Liquid dissemination is employed in the hand held aerosol irritant projectors and in several bulk dispensers presently on the market. In both cases, a gas is used to propel the liquid agent formulation to a selected target area. The nature and operation of the irritant projectors are described in Chapter Five and that discussion in equally applicable to the bulk liquid dispensers.

DELIVERY SYSTEMS

Over the years various munitions have been designed to deliver chemical agents to a desired release point. Since no single system has yet been designed to meet all tactical requirements, law enforcement agencies must select from available products an inventory that will permit the effective use of chemical agents under most or all anticipated field situations. Not only must decisions be made regarding the kinds of delivery systems necessary, but additional thought must be given to the quantity of munitions to be stocked. The remainder of this chapter will be devoted to a general discussion of delivery systems, while the important topics of procurement and prestock will be covered in Chapter Nine.

GRENADES

Chemical agent grenades are essentially containers designed to be hand activated and launched by law enforcement personnel with a minimum amount of training. With few exceptions, hand grenades are designed for use against crowds in open areas and it is only when they are used in confined spaces or against personnel who cannot escape from the agent concentration that serious risk of injury is incurred. Grenades are available with both CN and CS loading and employ either expulsion or pyrotechnic dissemination techniques.

Launchers are available for standard 12-gauge riot shotguns and the 1.5 caliber riot gas guns to permit some grenades to be projected for distances up to about 125 yards. A more recent innovation permits the launch of a small grenade from a .38 caliber service revolver. Because they are not stabilized in flight, the projected grenades tend to wobble and are not accurate

against point targets much beyond 40 to 50 yards. Accuracy, however, is not a primary consideration as the launchers are designed primarily to deliver grenades to a location upwind from area targets, with stabilized projectiles preferred where accuracy is needed to penetrate doors and window openings. Departments that stock grenades of more than one brand should be aware that launchers are designed by manufacturers for use *only* with their own grenades.

From a mechanical point of view, almost all commercial grenades operate in a similar manner up to the point of agent release. Except for the military M25A2 and the Lake Erie Mighty Midget, all currently available grenades employ a fuze similar to the M201A1 illustrated in Figure 5. A pull or safety ring is withdrawn from the fuze, extracting the arming pin. When the grenade is thrown or launched, the lever rotates outward around the "T" lug on the fuze body, releasing the striker. Activated by the striker spring, the striker hits the primer and ignites a delay element. Once the delay element burns through, it lights an ignition mixture which in turn ignites the fuel/agent mixture in burning grenades or the burster in expulsion grenades. From this point, munitions employ differing design features that govern the manner in which the agent is released from the container.

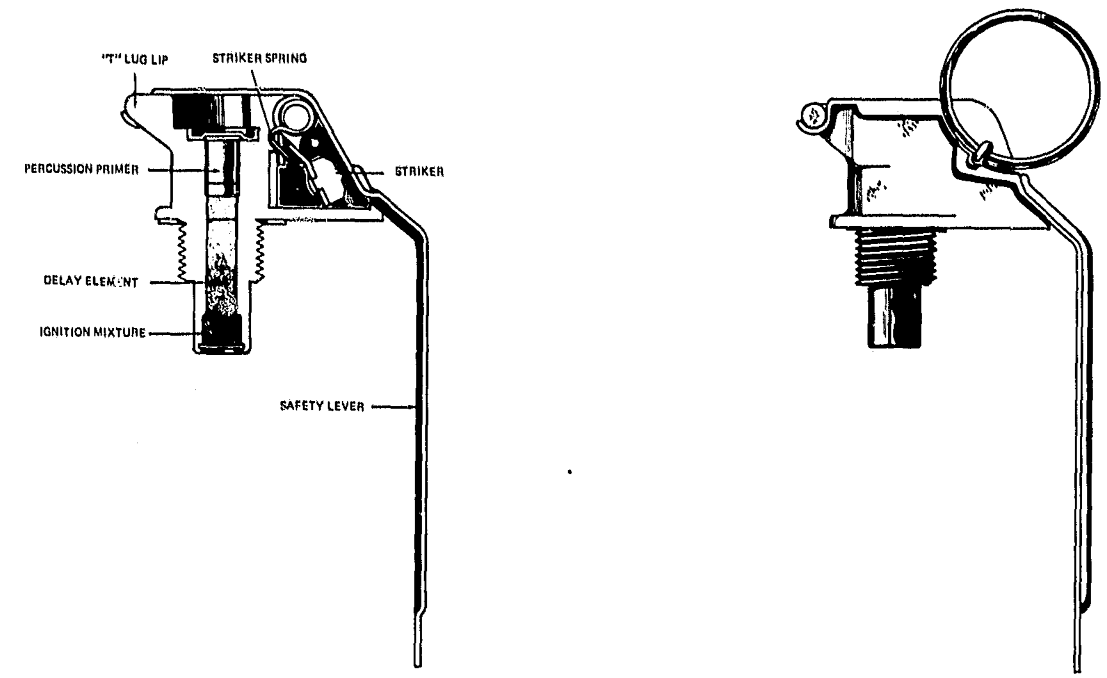


FIGURE 5 – THE MILITARY M201A1 FUZE
The hand grenade fuze is cocked and restrained from functioning by a safety pin. When the safety pin is withdrawn and the grenade thrown, a sequence of function is initiated: (1) The striker, driven by its spring, forces the safety lever out of its path, and the safety lever is thrown free of the grenade and releases the striker; (2) The striker strikes the percussion primer; (3) The primer emits a small intense spit of flame, igniting the delay element of the fuze; (4) Delay element burns for 1.2- to 2-seconds and sets off the ignition mixture of the fuze.

The military M25A2 employs an internal fuze arrangement activated by the release of a spring loaded slider which travels the length of the burster well to impact on a firing pin at the bottom of the well, exploding the detonator after a 1.4 to 3 second delay.

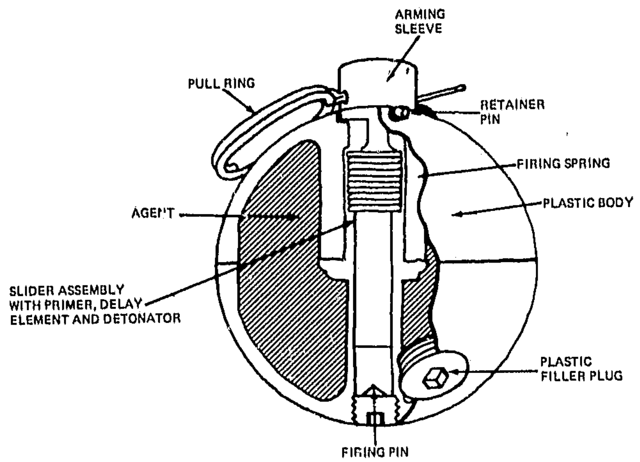


FIGURE 6 – THE M25A2 GRENADE FUZE

When the grenade is thrown, the arming sleeve is forced from the slider and (1) under pressure of the firing spring the slider moves toward the bottom of the burster well, (2) the primer in the end of the slider strikes the firing pin and ignites a delay element in the slider, (3) the delay element burns for 1.4 to 3 seconds and then sets off the detonator, and (4) the detonator explodes, shattering the grenade and dispersing the agent.

The Lake Erie Mighty Midget grenade employs a manual percussion fuze that is activated by striking the top of the fuze against a solid surface. The manual impact drives the striker against the primer, which in turn ignites the delay.

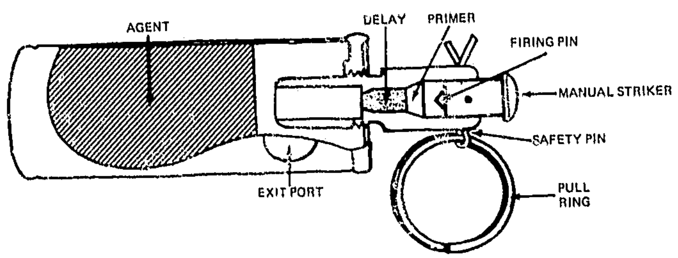


FIGURE 7 – MANUAL PERCUSSION FUZE

A sharp blow against the striker: (1) shears the safety wire and drives the striker against the primer; (2) the primer ignites the delay element; (3) the delay burns for approximately 2.5 seconds and (4) ignites the fuel/agent mixture.

The dilemma of current chemical agent munitions design is clearly evident in the variety of grenade products available. Each modification represents a continuing trade-off or compromise between desirable and undesirable performance characteristics as defined by the limited research and development capability available to civilian chemical munitions manufacturers in this country.

Expulsion or bursting grenades produce a relatively small but highly concentrated agent cloud. Because the release is instantaneous and the agent cloud is often difficult to see, this type of munition makes it hard for rioters to avoid the concentration or to take evasive action. The instantaneous release also makes it almost impossible for rioters to throw or kick bursting grenades back at police. In addition, the combination of surprise release and the accompanying discharge noise often produces a psychological effect that assists in dispersing an unruly crowd. Another advantage associated with some of the expulsion release systems is that they minimize or eliminate the hazard of fire when thrown into combustible materials.

On the other hand, grenades that disintegrate or shatter create a potential hazard from concussion or injury from flying particles of metal or plastic and for this reason are normally

rolled into crowds rather than thrown in a manner that will permit air bursts near exposed heads or faces. Unfortunately, ground bursts result in a considerable portion of the agent being dumped on the ground and consequently reduce the concentration of effective airborne particles. Those grenades that expel the agent from exit ports do not shatter or rupture and can therefore be rolled or thrown into crowds with the least risk of injury.

The newer "soft delivery" grenades combine many of the advantages of explosive disemmination without the hazards associated with fragmentation and concussion. In their present configuration these munitions are rather bulky, but they have several desirable features including the fact that they may be hand held and directed during release.

FIGURE 8.
EXPULSION GRENADES

RELEASE	CN	CS
Container Ruptures or Disintegrates	Federal Disintegrating 120 Federal Blast Dispersion 121 Lake Erie Blast Dispersion 3CN (Discontinued) Penguin Baseball G-1	Federal Disintegrating 520 Federal Blast Dispersion 514 Lake Erie Blast Dispersion 3CS (Discontinued) Military M25A2 Penguin Baseball
Agent Expelled Through Exit Port(s)	Lake Erie Model 34 CN Lake Erie Mob Master 7 CN Lake Erie Jumper Repeater 1CN AA1 Multi-Purpose MPG 100	Lake Erie Model 34 CS Lake Erie Mob Master 7 CS Lake Erie Jumper Repeater 1CS AA1 Multi-Purpose MPG 120

Pyrotechnic or burning grenades release an opaque cloud of white or grey smoke that carries the vaporized agent as it recondenses to submicron particles. Although burning time varies depending upon the amount of mixture, the munition design, and the formulation involved, most commercial grenades release their content in 15 seconds to 2.5 minutes. This release period permits rioters to take evasive action and perhaps kick the grenade canister away from their ranks or back toward police lines. While there have been reports from time to time of rioters picking up burning grenades and throwing them at police, this is not likely to occur with commercial grenades after the first 25 seconds of ignition unless gloves or padding are used to handle the burning canisters. The military M7A3 burning grenade, which has exit ports only on the top and base surfaces of the body, may remain cool enough to be picked up for a longer period.

Munitions manufacturers have responded to the threat of kick-back or diversion of burning grenades in several ways. One grenade is divided into three individual sections that are separated from each other by expelling charges when the grenade is activated. The noise of the black powder expelling charges often unnerves the rioters and the sudden separation of the grenade discourages returns, although the individual sections can still be kicked about after the separation occurs. Another grenade, still in the developmental stage, is reported to burn and expel its entire fuel/agent mixture in a 10-second period during which the rubber grenade body is constantly in motion.

Burning grenades produce a fire hazard when used in areas in which they come into contact with combustible materials. In outdoor use, the major risk of fire arises in connection with spilled gasoline from overturned automobiles and dry grass or underbrush. Again, manufacturers have responded by developing grenades that remain relatively cool during burning and emit little or no flame. To minimize the return problem encountered with cooler munitions, the new cool burning grenades have generally been designed to remain in motion during combustion.

FIGURE 9.
PYROTECHNIC GRENADES

CN	CS
Federal Spedeheat 112	Federal Spedeheat 555
Federal Triple Chaser 115	Federal Triple Chaser 515
Federal Pocket Grenade 109	Federal Pocket Grenade 109
Brunswick Skitter Grenade	Brunswick Skitter Grenade
Lake Erie Continuous Discharge 2CN	Lake Erie Continuous Discharge 2CS
Lake Erie Mighty Midget 98CN	Lake Erie Mighty Midget 98CS
	Military M7A2 & M7A3
	Penguin CS/Smoke
Penguin CN/Smoke G-3	Northrop Rubber Ball

Safety precautions must be followed in handling all types of grenades to prevent accidental injury to personnel or unintentional damage to property. Grenades should never be lifted or handled by the pull ring and most manufacturers caution against using the safety lever to hang grenades on the belt or from pockets.

Pull rings and safety pins should not be removed until a decision to launch the grenade has been made and a target selected. Once the pin is pulled, the safety lever must be held firmly against the body of the grenade until it is thrown. The pull ring and pin from the first grenade used should be retained in a pocket against the possibility that a subsequent grenade must be disarmed after its pin has been discarded.

Occasionally even the best chemical munitions will misfire (fail to ignite or explode) and police usually must accept the responsibility for dealing with these situations to prevent injury to innocent bystanders or law enforcement personnel. Munitions disposal is discussed in Chapter Nine.

Misfires can be kept to a minimum by careful handling of munitions to avoid excessive or unnecessary vibration or jolting. Grenades should not be removed from their sealed shipping containers until shortly before they are to be used. Exposure of unprotected munitions to rain, dampness, or high humidity contributes to misfires and should always be avoided in transportation and storage.

PYROTECHNIC WAND

The pyrotechnic chemical wand is a hand-held pyrotechnic dissemination device that produces a controlled concentration of CS for a period up to 4 or 5 minutes. The wand is useful for training purposes and can also be effectively employed to break up non-violent sit-in demonstrations in the open or in buildings.

The only wand currently available is a self-contained unit that comes complete with protective cover and a striker that can be used to ignite the wand. Once ignited, the wand burns progressively down the shaft until it burns out or is extinguished. Experience has proven that the wand is difficult to extinguish except by cutting completely through the wand below the burning point with a pair of bolt cutters.

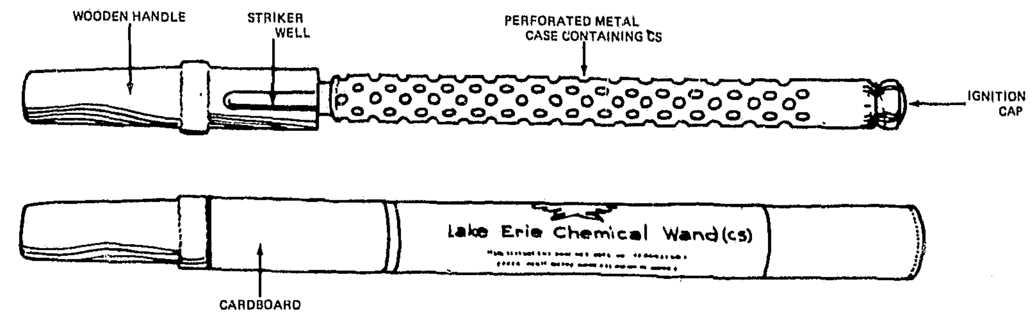


FIGURE 10
Pyrotechnic Wand

PROJECTILES

Projectiles designed to deliver riot control agents are more or less sophisticated containers that can be fired with some degree of accuracy from special 1.5 caliber riot gas guns or from the standard 12-gauge police riot shotguns. Most law enforcement agencies are equipped with at least one riot gas gun of the type illustrated in Figures 11 and 12. Although slightly different in design and functioning, both of these weapons are now built to accommodate ammunition on an interchangeable basis. However, this was not always the case and with older Lake Erie weapons it may be found that only Lake Erie Ammunition can be chambered.

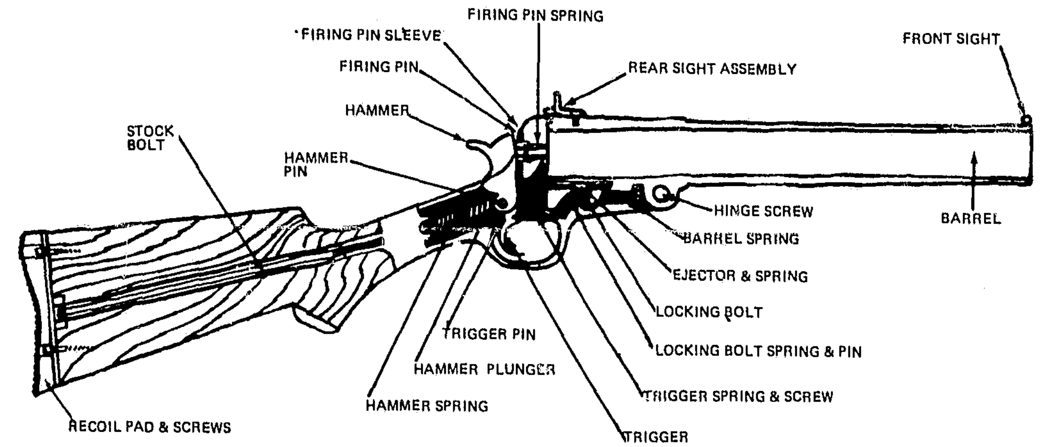


FIGURE 11
The Lake Erie Chemical Company 1.5 caliber (37mm) Tru-Flite Riot Gas Gun.

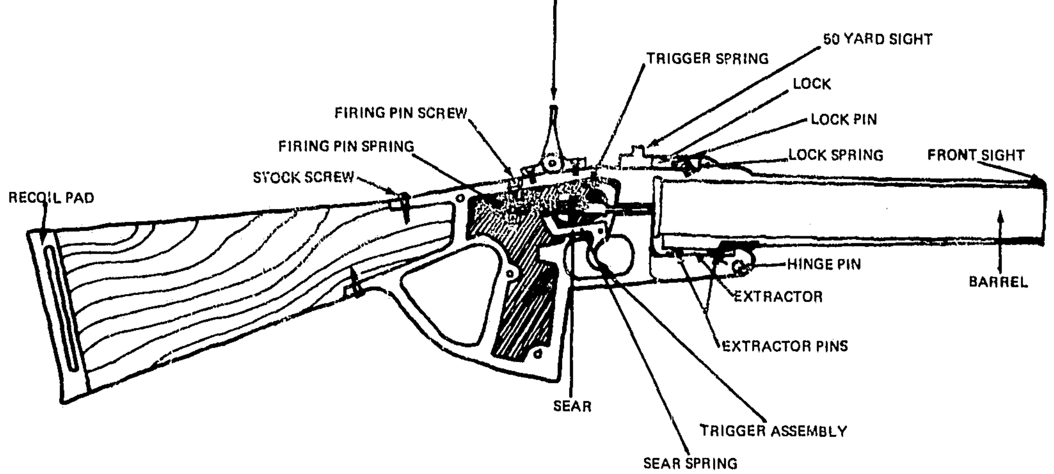


FIGURE 12
The Federal 1.5 caliber (38mm) Riot Gas Gun

While the effective concentration produced by projectiles depends upon the usual variables of weather and munition design, the 37-38 mm rounds can usually be expected to produce an agent cloud about 20 feet in diameter. The 12 gauge pyrotechnic projectile contains only 1/10 as much agent/fuel as the 1.5 caliber rounds and its output is reduced accordingly.

Projectiles may be classed as either stabilized or unstabilized on the basis of a design feature that provides fins to stabilize the projectile in flight, increasing substantially its accuracy throughout almost the full trajectory. Unstabilized projectiles tumble in flight and rarely exceed a maximum range of 150 yards. Since they usually cannot be accurately aimed to hit windows or other point targets at normal working ranges, the unstabilized projectiles are employed primarily against crowds in those cases where it is necessary to deliver chemical agents to an upwind point or against large target areas, such as rooftops or courtyards.

The maximum range of the unstabilized projectile can be shortened by aiming the riot gas gun to achieve a higher trajectory or by aiming downward to cause the projectile to bounce along the ground to the desired release point. From the standpoint of both economy and efficiency, the unstabilized projectile should be the delivery system of choice only in those cases where its particular characteristics are required. When wind conditions and field position are favorable, greater cost/effectiveness is achieved through the use of grenades or bulk dispensers.

The stabilized projectiles can, with sufficient practice, be fired with reasonable accuracy at point targets at a range of up to 100 yards. The muzzle velocities achieved by these projectiles, 225-325 feet per second, enable them to penetrate windows, doors, and even room partitions. On the other hand, such velocities preclude the use of stabilized projectiles against personnel because of the likelihood of injury or death. They are designed and intended for use only against barricaded criminals and should never be used against crowds in riot control situations where the risk of serious injury or death is not acceptable.

FIGURE 13.
Common 1.5 Caliber (37-38mm)
Projectiles

CLASS	DISSEMINATION	DESIGNATION	MAXIMUM RANGE (YARDS)	MODEL/CATALOG NUMBER CN	CS
UNSTABILIZED	EXPULSION	Lake Erie Long Range Riot Shell	150	16 CN	16 CS
		Federal Mark 200	150		507 CS
		Federal Blast Dispersion Projectile	150	233 CN	
		Federal Mark 70	90		505 CS
		Federal Blast Dispersion Projectile	90	234 CN	
	PYROTECHNIC	Federal Spedeheat (Long Range)	150	206 CN	560 CS
		Federal Spedeheat (Short Range)	90	219 CN	570 CS
STABILIZED	EXPULSION	Federal Impact Flite-Rite	325	232 CN	509 CS
		Lake Erie Tru Flite Shell	350	11 CN	11 CS
	PYROTECHNIC	Federal Flite-Rite	325	230 CN	530 CS

All of the common 37-38 mm projectiles, both stabilized and unstabilized, utilize either pyrotechnic or expulsion dissemination similar to that employed by grenades. The effectiveness of these devices depends to a large extent upon the skill and knowledge of the officer using the riot gas gun. Unfortunately, in many departments the infrequent need for chemical agents in the past has led to a serious deficiency in training with the 1.5 caliber weapon. It is also not unusual to find that only one or two officers in an agency are even familiar with operation of the gun.

FIGURE 14.
Common 12 Gauge Projectiles

CLASS	DISSEMINATION	DESIGNATION	MAXIMUM RANGE (YARDS)	MODEL/CATALOG NUMBER CN	CS
UNSTABILIZED	EXPULSION	Penguin Barricade Projectile	75		GSA-14
UNSTABILIZED	PYROTECHNIC	Penguin Long-Range Cartridge	250	GSA-12	GSA-12
STABILIZED	LIQUID	AAI Barricade Projectile	500		SGA-100

Consequently, the riot gas gun is either ignored completely in tactical operations or is employed by inexperienced personnel with less than satisfactory results. Perhaps the most common problem encountered involves the use of the high muzzle velocity, stabilized, pyrotechnic projectile at short ranges. This practice usually results in the projectile passing completely through the target room and sometimes through the entire building, a situation that could be avoided through the use of projectiles employing impact fuzing.

The cost of specialized riot gas gun equipment and munitions, the necessary training, and the problems associated with insuring that equipment is available quickly when and where it is needed have led to the development of 12 gauge projectiles that can be fired from the standard riot shot guns that are carried in patrol vehicles in many jurisdictions. The limited output available from the unstabilized pyrotechnic 12 gauge projectiles has made their usefulness marginal. However, the newer barricade projectiles appear to offer greater potential and a round employing a liquid CS dissemination is currently under advanced development. The availability of a low cost, accurate, and effective 12 gauge projectile for use against barricaded criminals would cut sharply into the utility of the traditional 1.5 caliber weapons.

Many of the risk factors associated with projectiles are similar to those encountered with grenades. As previously mentioned, the relatively high velocity stabilized projectiles can hardly be classed as non-lethal in nature. The unstabilized projectiles, because of their lower muzzle velocity and tumbling flight pattern are less likely to produce serious personnel injury, although this possibility cannot be completely discounted. The burning projectiles, which reach a temperature in the vicinity of 300° during release, produce fire risk by virtue of both the burning of the delay chain and the combustion of the fuel/agent mixture.

CARTRIDGES

Chemical agent cartridges of all sizes employ an explosive force to eject a cloud of micropulverized agent from the muzzle of a standard firearm or from specially designed weapons such as the pen and pocket guns popular in some areas of the United States. The cartridge itself remains in the weapon, with only the chemical agent, seals, wads, and combustion byproducts exiting from the muzzle of the firing device.

Although chemical agent cartridges are available in sizes compatible with most firearms, from .22 caliber through 12 gauge, these munitions are extremely inefficient and generally provide a poor vehicle for dissemination. To achieve an incapacitating effect, the small arms chemical ammunition must be fired directly into the face of an individual at almost point blank range. The injury risk and ineffectiveness associated with this kind of dissemination has generally caused police agencies to avoid employing the muzzle blast cartridges in weapons smaller than the 1.5 caliber (37-38 mm) riot gas gun, although 12 gauge cartridges are occasionally stocked in smaller departments that have no 1.5 caliber equipment.

The 1.5 caliber blast cartridges typically project an agent cloud about 20 to 30 feet from the muzzle of the gun, with the actual range depending primarily upon wind direction. Although these gas gun cartridges are designed to minimize the risk of injury from flying fragments of wads and seals, the agent load can produce serious damage to skin and eyes if it is blasted directly into the faces of exposed individuals. For this reason it is recommended that the cartridge loaded gas gun be aimed at the lower body rather than the face and shoulders of target personnel.

Even in the larger 1.5 caliber size, cartridges represent a relatively expensive and inefficient way to produce an effective chemical agent concentration. For this reason the cartridges should be used only in those situations where their particular characteristics are demanded. Blast cartridges are perhaps best employed to disperse small groups of people or to deny rioters access to buildings or enclosures where a narrow passage can be effectively blocked by the cartridge discharge. Traditional riot control doctrine also calls for the use of cartridges to lay down a final protective line against crowds advancing on police formations.

BULK DISPENSERS

Bulk or mechanical dispensers are designed to produce large concentrations of chemical agent in those situations where wind condition and field position permit their use. Although these devices project the agent with varying degrees of velocity, they all depend to a great extent upon favorable wind currents to achieve a maximum level of effectiveness. Available bulk dispensers employ either the expulsion, liquid, or fog dissemination technique.

The *expulsion* dispensers employ a pressurizing gas, such as dry nitrogen or compressed air, to project clouds of micropulverized chemical agent for distances up to 50 or 75 feet in a still air. Typically, the flow rate is very rapid and only controllable by the length of time that the triggering assembly is depressed. Most of the expulsion devices can be reloaded with agent in the field, but repressurizing often presents a problem.

FIGURE 15.

Expulsion Dissemination Bulk Dispensers

DESIGNATION	PRESSURIZATION	LOADED WEIGHT (pounds)	CAPACITY	DISCHARGE PRESSURE (p s i)
B&H, Incorporated				
PTG-100	Nitrogen	37	5 pounds	50
PTG-200	Nitrogen	46	10 pounds	50
Military				
M-3 (personnel)	Compressed air	55	8 pounds	70
M-5 (vehicle)	Compressed air	210	50 pounds	45
Penguin				
Crowd Dispenser	Nitrogen	2.5	5 ounces	
Tabor				
PTG-3	Nitrogen	35	8 pounds	40
PTG-6	Nitrogen	55	16 pounds	40

Department of the Army Field Manual FM 19-15, March 1968, provides instructions for converting standard dry charge 2 3/4 and 10 pound fire extinguishers into expulsion dispensers for micropulverized agent. The modification can be accomplished with a minimum amount of time and effort and the improvised dispenser reportedly performs well. Figure 16 compares the improvised units with the familiar military M3 Portable Riot Control Agent Dispenser.

FIGURE 16.

Comparison of Improvised Bulk Dispensers With The Military M-3 Unit.

(FM 19-15, March 1968)

	2¾ lb	10 lb	M-3
a. Range (in still air)	15 ft	40 ft	40 ft
b. Duration of Firing (single bursts)	4 sec	8 sec	19 sec
Several Short Bursts (3-4 seconds)	6 sec	13 sec	30 sec
c. Maximum Pressure	150 psi	240 psi	2,100 psi
d. Maximum Operating Pressure	90 psi	90 spi	80 psi
e. Effective Operating Pressure	90 psi	90 psi	70 psi
f. Minimum Operating Pressure	60 psi	60 psi	65 psi
g. Weight (empty)	2 lbs	10 lbs	47 lbs
h. Weight (filled and charged)	3 lbs	14 lbs	55 lbs
i. Cloud travel distance (downwind)	150+M	200+M	200+M
j. Area Coverage	2,000 M² (150Mx22M)	4,500 M² (200Mx22M)	4,800² (200Mx24M)
k. Time required to fill and pressurize	6 min*	12 min*	28 min*

* Time will vary with training and experience of personnel involved.

Note: The above figures (i-j) were obtained by firing the disperser with following winds of approximately 10 to 12 mph. Extremes of temperature have no appreciable effect on the operation of the dispersers.

Liquid dissemination bulk dispensers employ a pressurizing gas in the same manner as an expulsion dispenser to project the chemical agent to the target in a liquid state. The current liquid disseminators have not been widely used under actual riot conditions, but the selectivity and limited contamination permitted by liquid dissemination may offer potential for

future development, especially if appropriate formulations can be found. The direct and heavy application of the chemical formulations employed in hand-held irritant projectors is risky and should be approached with great caution.

Fog generators disseminate large volumes of inert or irritant fog and feature, for the first time, controls to vary the agent concentration. Two basic types of fog devices are available to the law enforcement field. Both operate by rapidly vaporizing a high boiling point liquid, which may or may not contain an irritant, exposing it to a hot gas flow, and then mixing the resulting hot vapors with much cooler ambient air causing them to condense into a fog.

The first of the fog devices uses a resonant pulse jet engine as the heat source. This engine is a simple type of hot gas generator that consists of a stainless steel tube with an enlarged section at one end forming a combustion chamber. It operates by exploding a mixture of fuel and air in the combustion chamber, with the resultant pressure driving the hot combustion gases down the exhaust pipe. The momentum of these gases causes a subatmospheric pressure to develop behind them, allowing the intake valve to open and admit more air/fuel mixture. Each new mixture is again ignited in the combustion chamber, with the cycle repeated many times per second. Once the engine comes up to operating temperature, combustion is self sustaining and the spark plug, which was used for starting, is no longer needed. The resonant pulse jet engine uses regular gasoline for fuel with no oil required. The liquid to be fogged is sprayed into the hot combustion gases part way down the exhaust pipe causing them to vaporize. At the end of the pipe, these hot vapors are mixed with cooler ambient air and condensed into a fog.

The other type of fog generator available to law enforcement uses a conventional two cycle engine as a heat source. The engine, which burns a mixture of gasoline and oil, is also coupled to a centrifugal blower to provide velocity to the agent cloud release. The liquid formulation is sprayed into the exhaust manifold where it is vaporized and then directed to the mouth of the blower where the cool blast condenses it into a fog. The fog is projected and diluted by the air from the blower, expanding its apparent volume.

FIGURE 17.

Fog and Liquid Dissemination Bulk Dispensers

DESIGNATION	TYPE	LOADED WEIGHT (pounds)	CAPACITY (quarts)	FUEL/PRESSURE
Federal Jet-Fogger	Fog	37.25	1	Gasoline/oil
General Ordnance Equipment Corporation				
Pepper Fog	Fog	27	4	Gasoline
MK-17	Fog	36	2	Gasoline/oil
Middle West Marketing Chemical Weapon	Liquid	28	5	Nitrogen

In situations where conditions are favorable for their employment, bulk dispensers provide the most economical and effective method for applying agent concentration over large areas. While the devices dispersing micropulverized CS produce a characteristic contamination problem, the newer fog generators create a surprisingly low level of contamination even when the CS formulations are used.

Perhaps the single most important consideration in the employment of bulk dispensers is training. All of the bulk dispensers are capable of delivering large concentrations of chemical agent in a very short period of time. This means that operators must be extensively trained in fire control and risk evaluation. Additionally, the typical dispenser is neither a simple nor a foolproof device and operators must be trained in procedures for field maintenance and reloading under difficult conditions. While most chemical munitions can be employed by the average police officer with a minimum of training, dispenser operators should be well trained specialists with the technical knowledge and mature judgement necessary to operate the bulk dispenser in such a manner as to obtain maximum tactical effectiveness with a minimum of risk to both police and the public.

EVALUATING DELIVERY SYSTEMS

The choice of a delivery system depends upon the mission to be accomplished. The differing characteristics of various devices must be considered in relation to risk, cost, and effectiveness. Unfortunately, the entire evaluation process is currently hindered by a lack of reliable performance data on chemical munitions.

In the final analysis, the most important criteria for the evaluation of a delivery device is an accurate indication of the concentration of effective airborne agent produced. While manufacturers are usually willing to provide varying amounts of descriptive information on the basic physical characteristics of their products, they are usually unable, and occasionally unwilling, to provide data regarding effective (in terms of particle size) airborne concentrations. Without this kind of information it is impossible to make reasonable judgements regarding the relative merits of either basic dissemination methods or specific products.

The development of concentration data requires the use of highly sophisticated and extremely expensive testing facilities. There are perhaps not more than half a dozen laboratories in the United States capable of generating the needed information and none of these facilities are owned by firms currently producing chemical munitions for police use. In an effort to fill this critical information gap, the IACP has asked the Law Enforcement Assistance Administration of the U. S. Department of Justice to support independent research leading to the evaluation of those chemical munitions currently in use by law enforcement agencies. Should LEAA respond favorably to this research proposal, police officials may finally have access to the information that they need to guide their procurement and tactical use of chemical munitions.

CHAPTER FOUR

Tactical Use of Chemical Agents

A wide range of factors are capable of influencing the effectiveness of chemical agents employed under field conditions by the police. Because the impact of these various factors is directly related to the specific tactical objectives desired, it is difficult to make categorical statements that will apply uniformly to all situations.

While it might be more comfortable to have a set of absolute rules for the employment of chemical agents, the almost infinite variety of possible situations provided by the interplay of differing *objectives* and relevant *influencing factors* suggests that there can be no substitute for field commanders with the necessary knowledge of chemical agent technology to make timely and accurate tactical decisions in response to specific situations. The only way that such decisions can be made is with a full understanding of the factors that influence the effectiveness of chemical agents and a general appreciation of the tactical objectives for which such agents are appropriate.

EFFECTIVENESS FACTORS

The factors that influence the effects of chemical agents can be classified into three general groups; meteorological conditions, munition characteristics, and target nature. They are conditions that can, under certain circumstances, influence or dictate the success or failure of a chemical agent operation. The importance of any particular factor depends upon the nature of the mission at hand and, in some cases, many or all of the effectiveness factors may be irrelevant to the successful achievement of an objective. In the long run, however, the ability of a police organization to effectively, economically, and safely employ chemical agents under the demands of a wide range of tactical conditions will depend upon some understanding of the variables discussed in this section.

1. **METEOROLOGICAL CONSIDERATIONS** The localized weather elements of wind, temperature, temperature gradient, and humidity are the result of continually changing major meteorological conditions and are extremely difficult to forecast with any degree of accuracy. For this reason, the police, who are concerned only with the employment of chemical munitions on a relatively small scale, usually must assess weather conditions in the field at the time and place where the agent will be employed.

a. *Wind.* Wind is moving air which normally tends to travel parallel to the earth's surface. Because chemical agent clouds travel with the air, it is important for those employing chemical munitions to understand something about how air is likely to move in any given situation. Much of the confusion in present tactical chemical agent operations stems from the fact that agents often perform differently in the hot, high-rise, urban setting than they do in the wide open countryside where past demonstrations and training have taken place.

FIGURE 1 – SUMMARY OF FACTORS AFFECTING THE EFFECTIVENESS OF CHEMICAL AGENTS

		CONTROLS OR LIMITS									
FACTOR		MUNITIONS		CONCENTRATION					SYMPTOMS		
		Placement	Quantity	Density	Difusion Rate	Coverage Speed	Coverage Area	Contamination	Skin	Respiratory	Psychological
Meterological Conditions	Wind Direction	✓	✓				✓				
	Wind Speed	✓	✓		✓	✓	✓				
	Wind Turbulance						✓				
	Temperature Gradient		✓	✓	✓				✓		
	Humidity/ Precipitation		✓	✓ 1			✓ 1	✓	✓	✓	
Munition Characteristics	Particle Size										
	Diffusion Rate		✓	✓	✓						
Target Nature	Breathing Rate									✓	
	Experience										✓

[1]Smoke Only

Three important wind considerations are direction, speed, and turbulence. *Wind direction* dictates the point at which chemical munitions should be released. Grenades and projectiles must be placed in front of the target if there is a following wind or behind the target area if there is a headwind. In the case of flanking or quartering winds, munitions are ideally placed on the upwind flank.

The direction from which the wind is blowing is always used to designate wind direction. (Figure 2) Although we can speak of wind direction in a general sense, the normal flow of local air is not steady or constant. Its direction undergoes minor, spasmodic changes from the prevailing direction and these variations tend to be greater in winds of low speed and lesser in stronger winds. In winds of very low speed, less than 4 miles per hour, wind direction fluctuates widely.

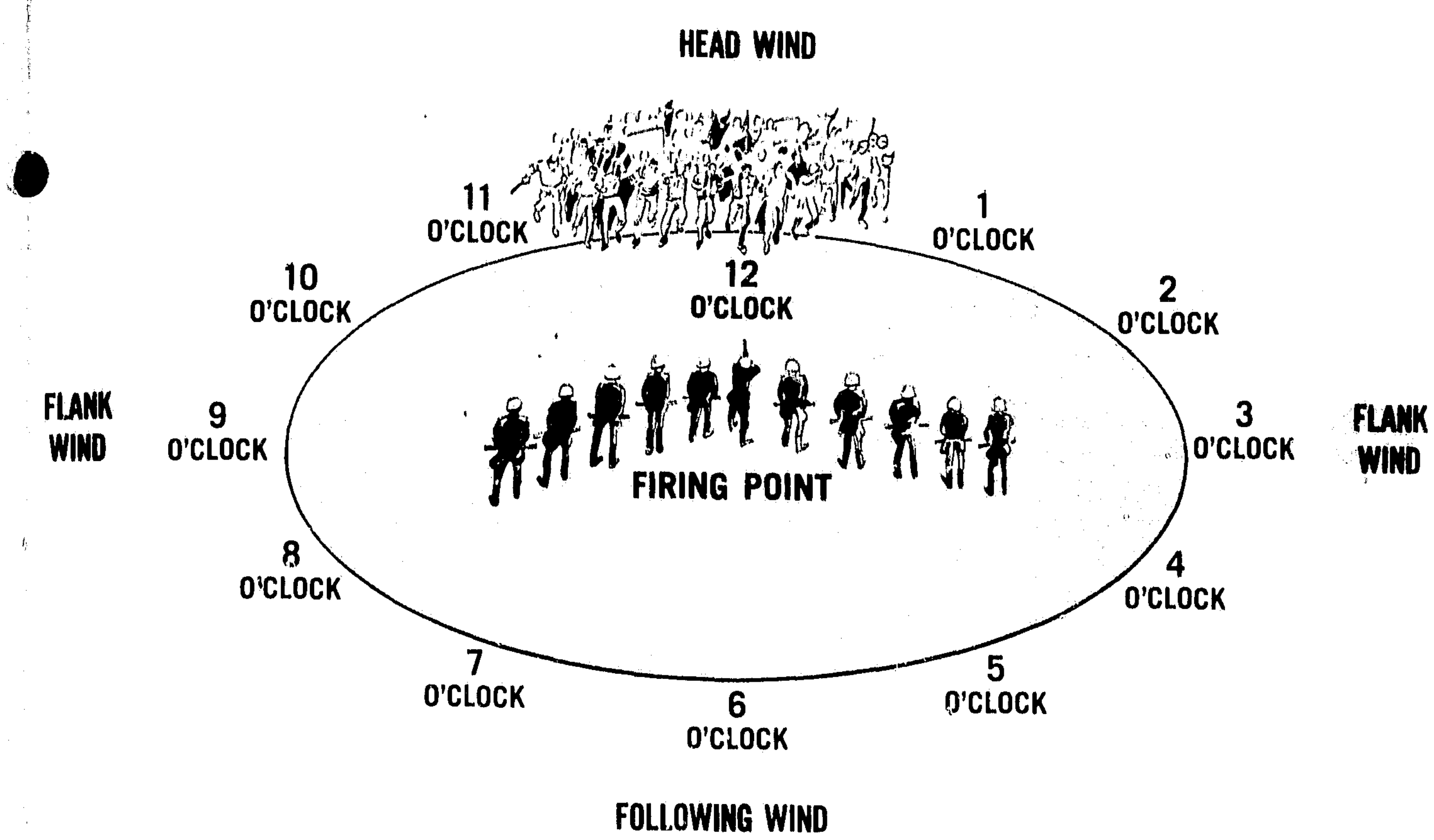


FIGURE 2 – SYSTEM FOR DESIGNATING WIND DIRECTION

Wind speed controls the rate at which both vapors and aerosols dissipate. The higher the wind speed the greater the number of munitions that will be required to establish a given concentration of riot control agent. On the other hand, a higher wind speed permits a more rapid coverage of any specific target area. As a general rule, winds from 5-10 miles per hour are the most effective for the use of riot control agents. Low wind speeds may allow the cloud to rise too rapidly and higher velocities tend to disperse the cloud too quickly or to break it up into less effective smaller clouds.

Wind speed also affects munition placement since lower wind speeds permit the agent clouds from two or more munitions to merge at a comparatively short distance from their sources. Thus when winds are higher, the munitions must be placed either closer together or further from the target area in order to insure a uniform area coverage. (Figure 3)

Wind turbulence refers to short gusts and lulls that are variable in direction, strength, and duration. Turbulence is irregular air movement that occurs contrary to the prevailing wind flow. There are two kinds of turbulence, mechanical and thermal, and both can create localized problems in the delivery of chemical agents.

Mechanical turbulence is the result of wind speed and surface obstacles that create eddies and gusts. Naturally, mechanical turbulence is greatest when a strong wind blows across an irregular ground surface. (Figure 4) Thermal turbulence, which is produced by the sharp vertical rise of air from heated surfaces, is discussed below in the section regarding temperature gradient. Unfortunately, there is no method for measuring turbelence in the field and chemical agent officers can only attempt to anticipate any delivery problems that it might produce and place munitions accordingly.

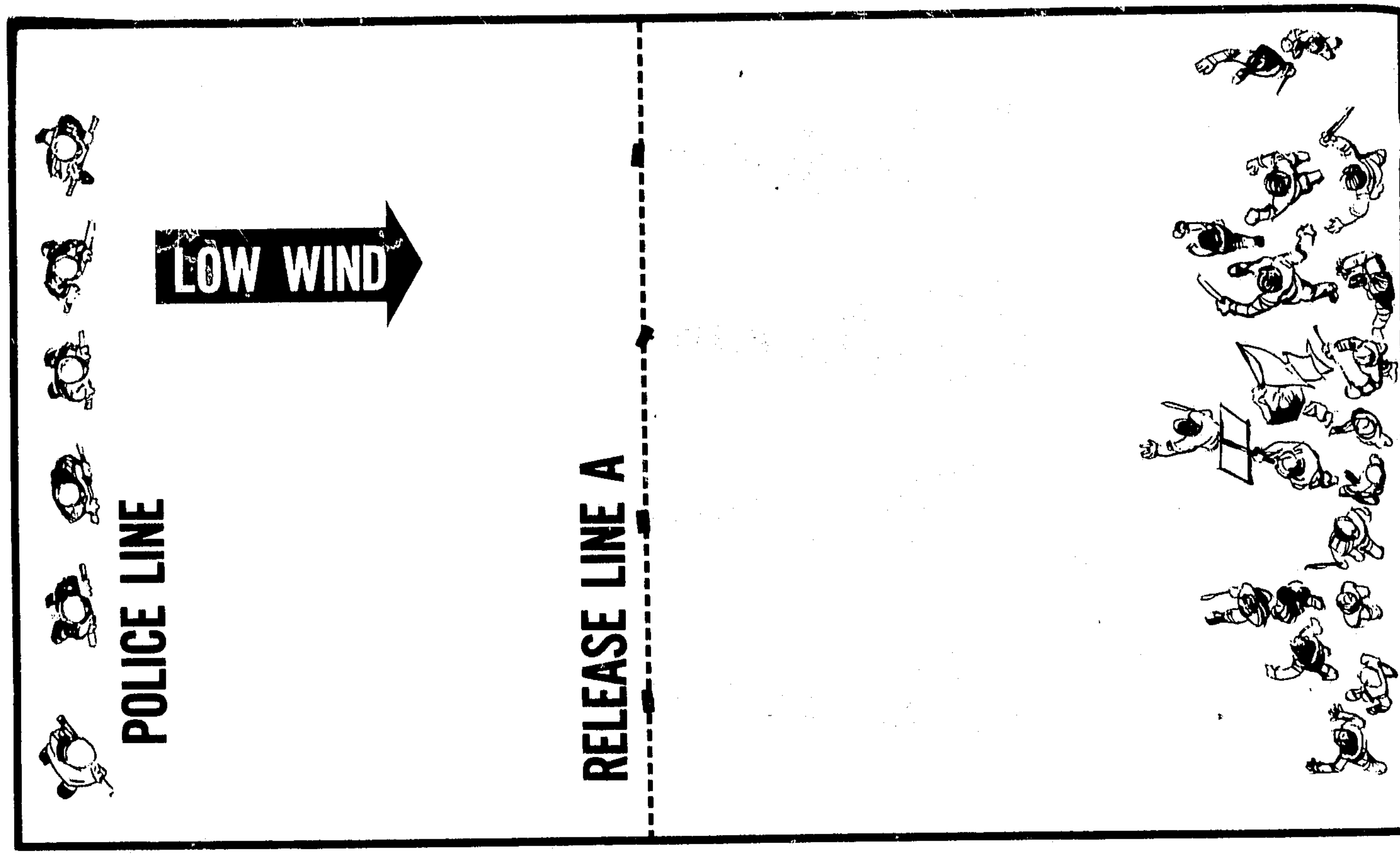


FIGURE 3A – WIND SPEED EFFECT ON MUNITIONS PLACEMENT. IDEAL RELEASE PATTERN

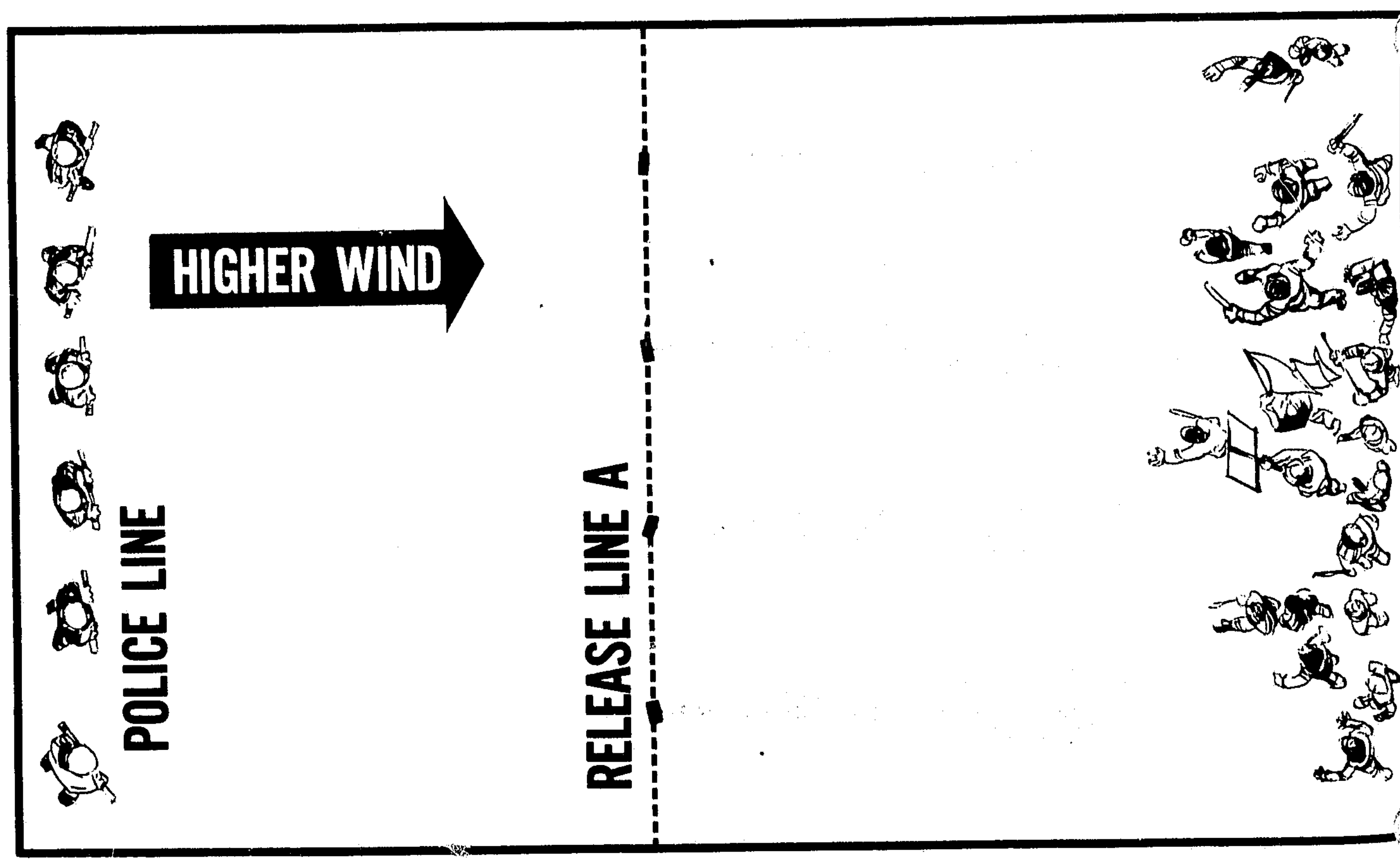


FIGURE 3B – WIND SPEED EFFECT ON MUNITIONS PLACEMENT. INADEQUATE COVERAGE CAUSED BY INCREASED WIND SPEED

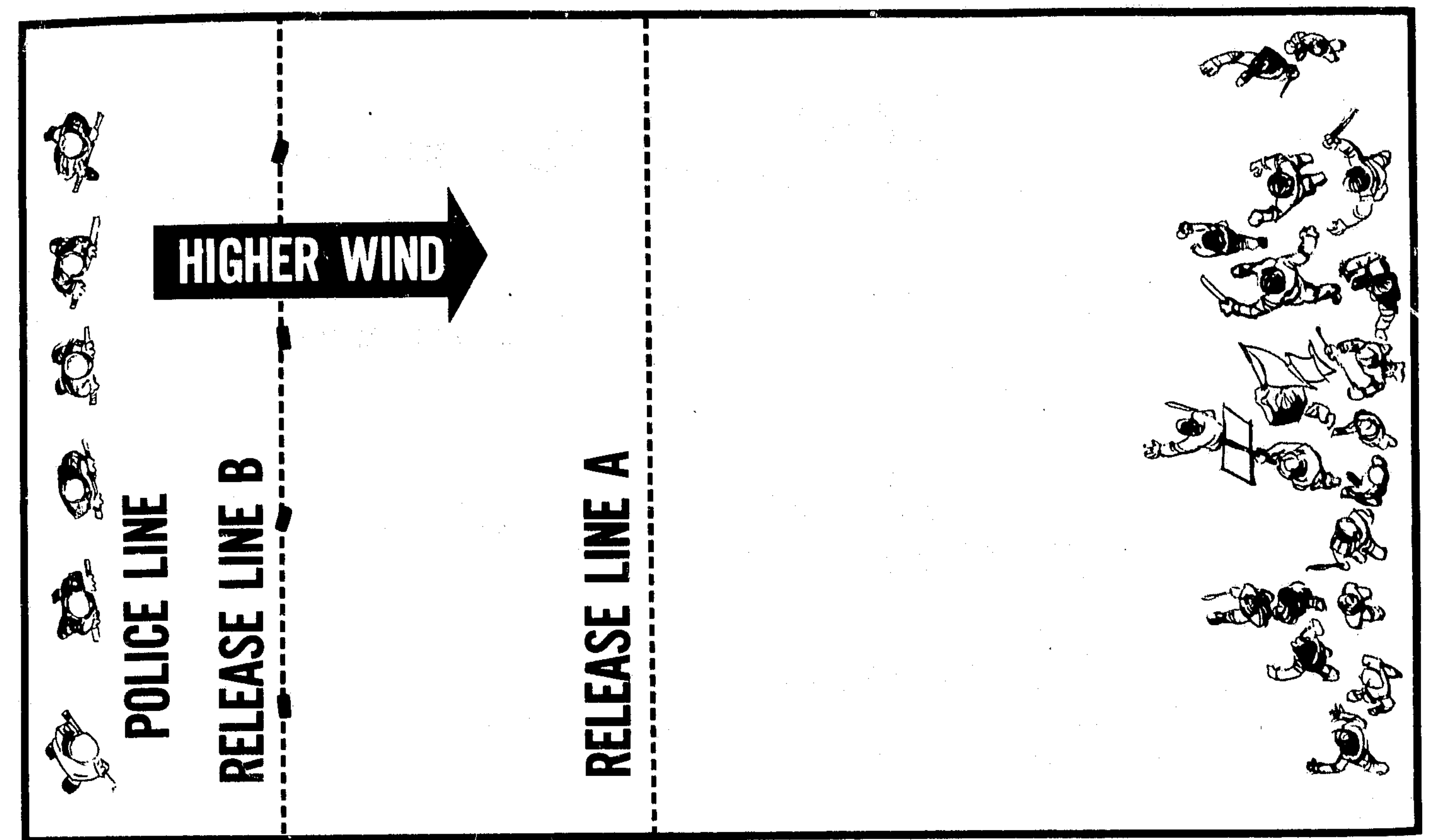


FIGURE 3C – WIND SPEED EFFECT ON MUNITIONS PLACEMENT
INADEQUATE COVERAGE CORRECTED BY ADJUSTING RELEASE LINE LOCATION

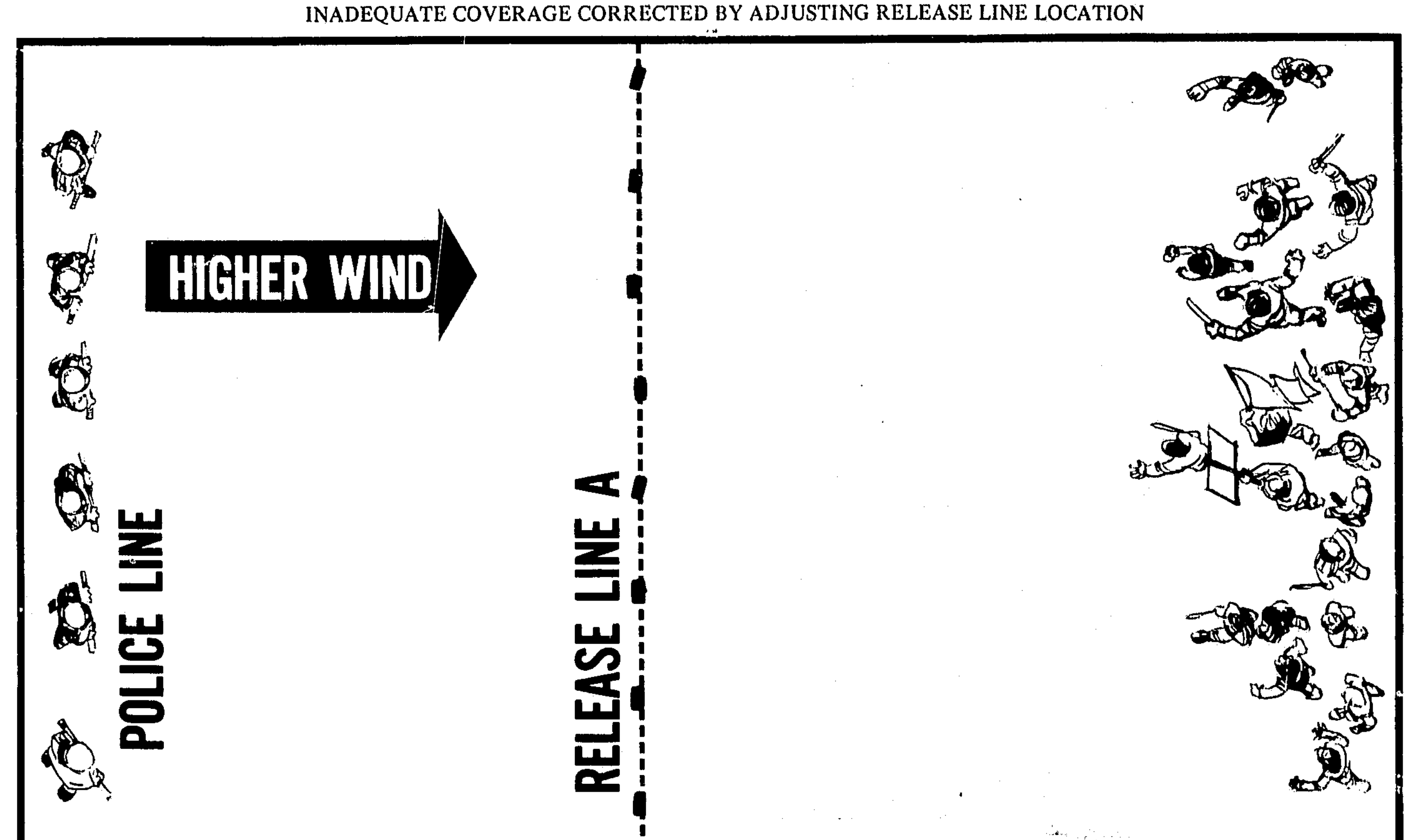


FIGURE 3D – WIND SPEED EFFECT ON MUNITIONS PLACEMENT.
INADEQUATE COVERAGE CORRECTED BY USING ADDITIONAL MUNITIONS

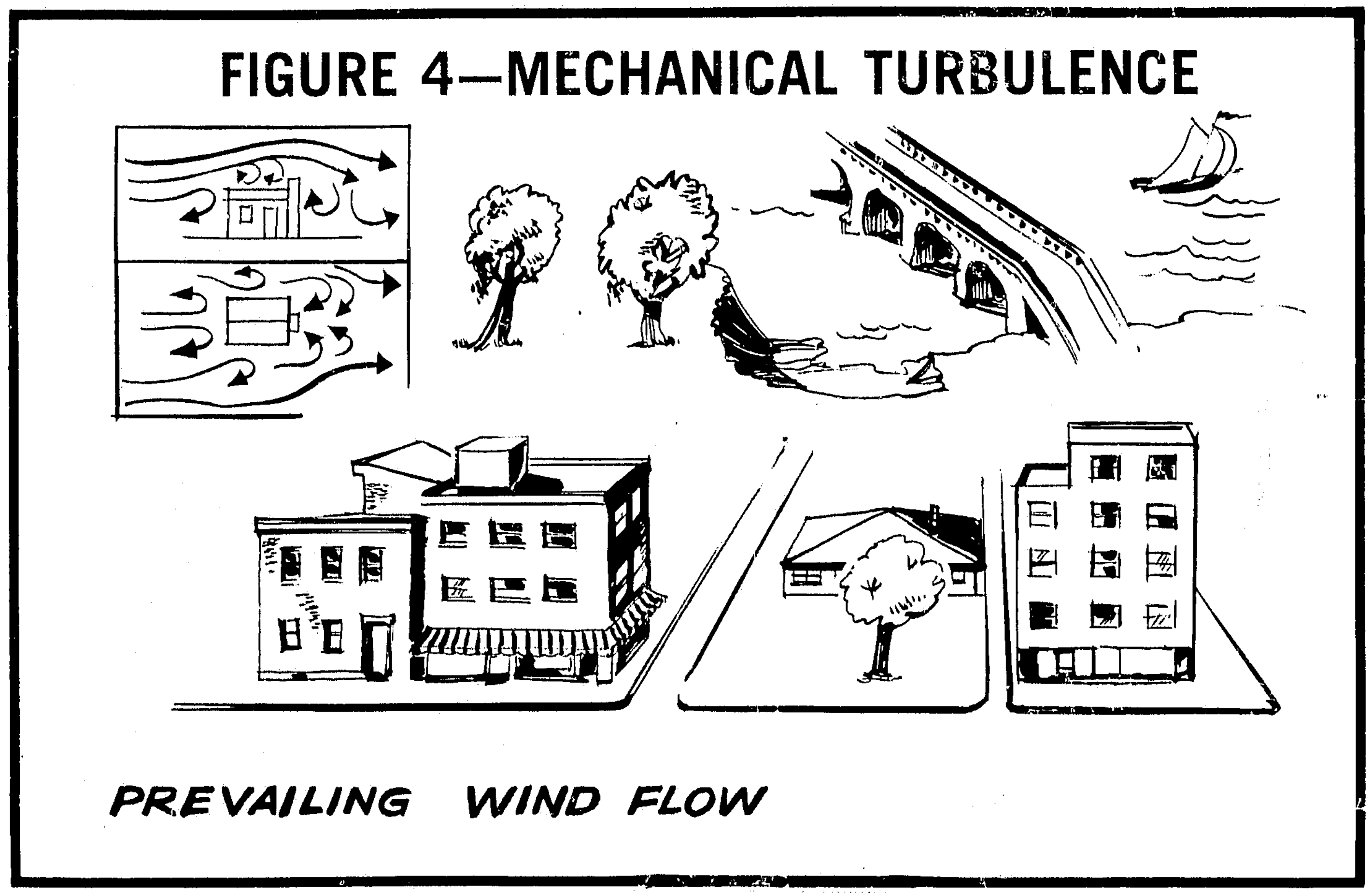


FIGURE 4 – MECHANICAL TURBULENCE

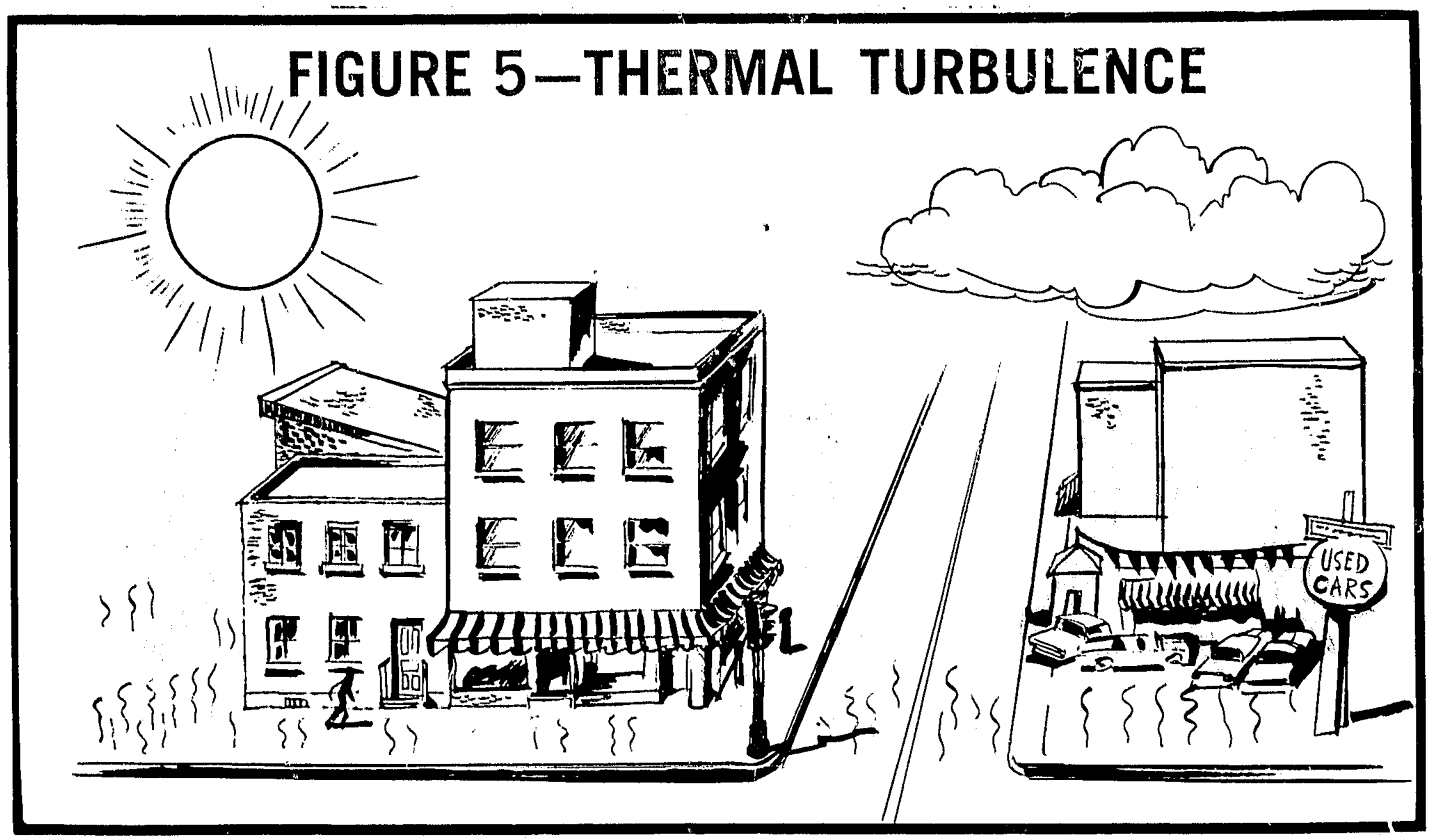


FIGURE 5 – THERMAL TURBULENCE

b. *Temperature Gradient.*[1] The stability of the surface air layer is governed by the variation in air temperature within 6 feet of the ground level. Air stability is expressed as the vertical temperature gradient. The temperature gradient for chemical agent operations is determined by subtracting the air temperature at 1 foot above the ground from the air temperature at 6 feet above the ground. Three temperature gradients are distinguished in the employment of chemical agents. (Figure 6)

[1]The following five paragraphs in this section were adapted with minor modifications from Department of the Army Technical Manual TM 3-240, May 1963.

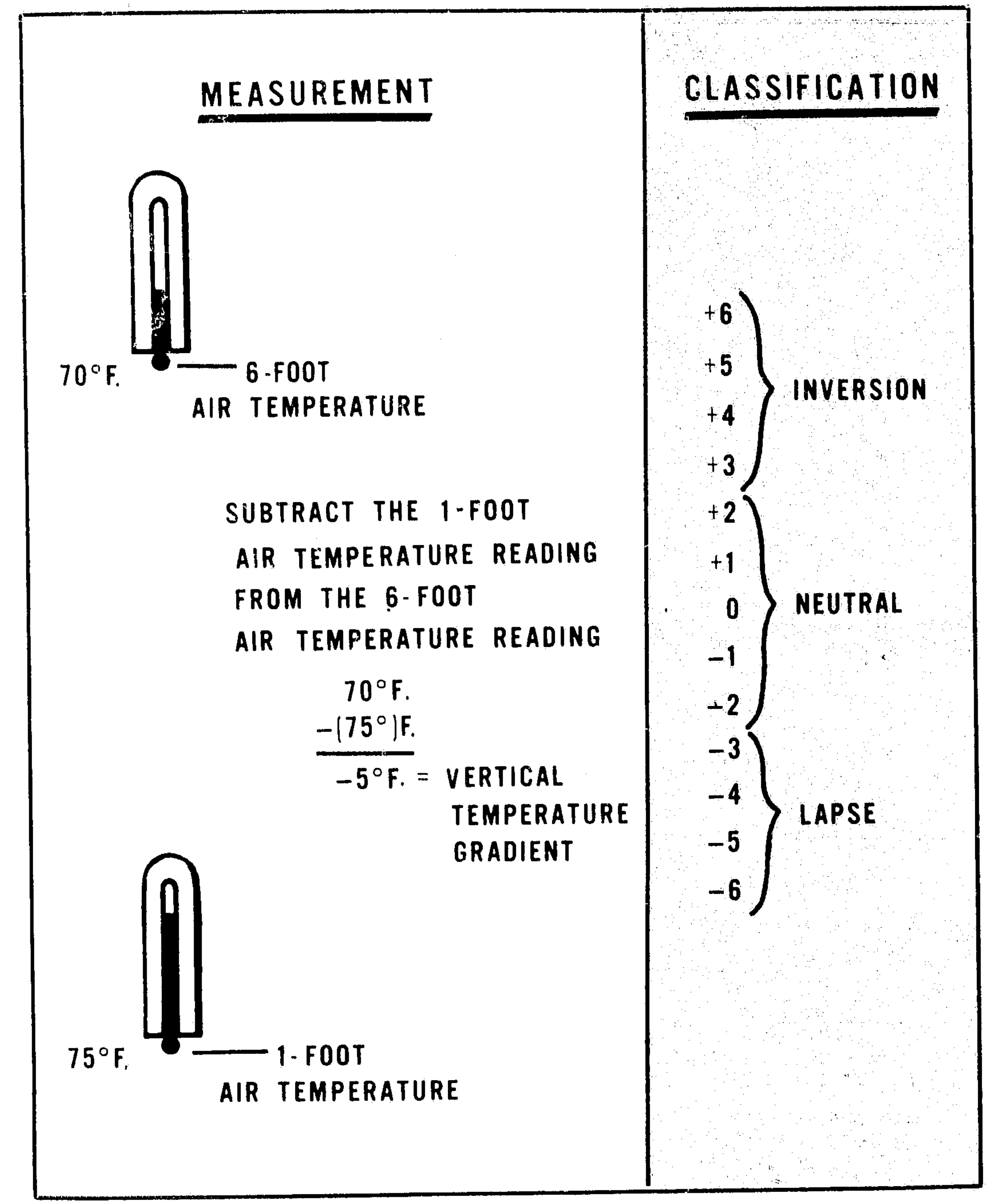


FIGURE 6 – MEASUREMENT AND CLASSIFICATION OF VERTICAL TEMPERATURE GRADIENTS.
(DA Technical Manual TM 3–240, May 1963)

Thermal Turbulence. An air parcel warmer than its environment tends to rise and to be displaced by descending or surrounding cooler, denser air. The variable rates of heating and cooling of adjacent bodies of air cause density differences (that is, neighboring parcels of different temperature and density) and result in convection currents. When convection is great, considerable amounts of air are exchanged between high and low levels.

When convection is slight, less air is carried from one level to another, and the air near the ground is only slightly influenced by mixing with upper level winds. Inversion conditions tend to resist and suppress vertical convection currents (as well as mechanical turbulence) and such a layer is, therefore, said to be stable. Lapse conditions offer little resistance to vertical currents (turbulence), and such a layer is said to be unstable.

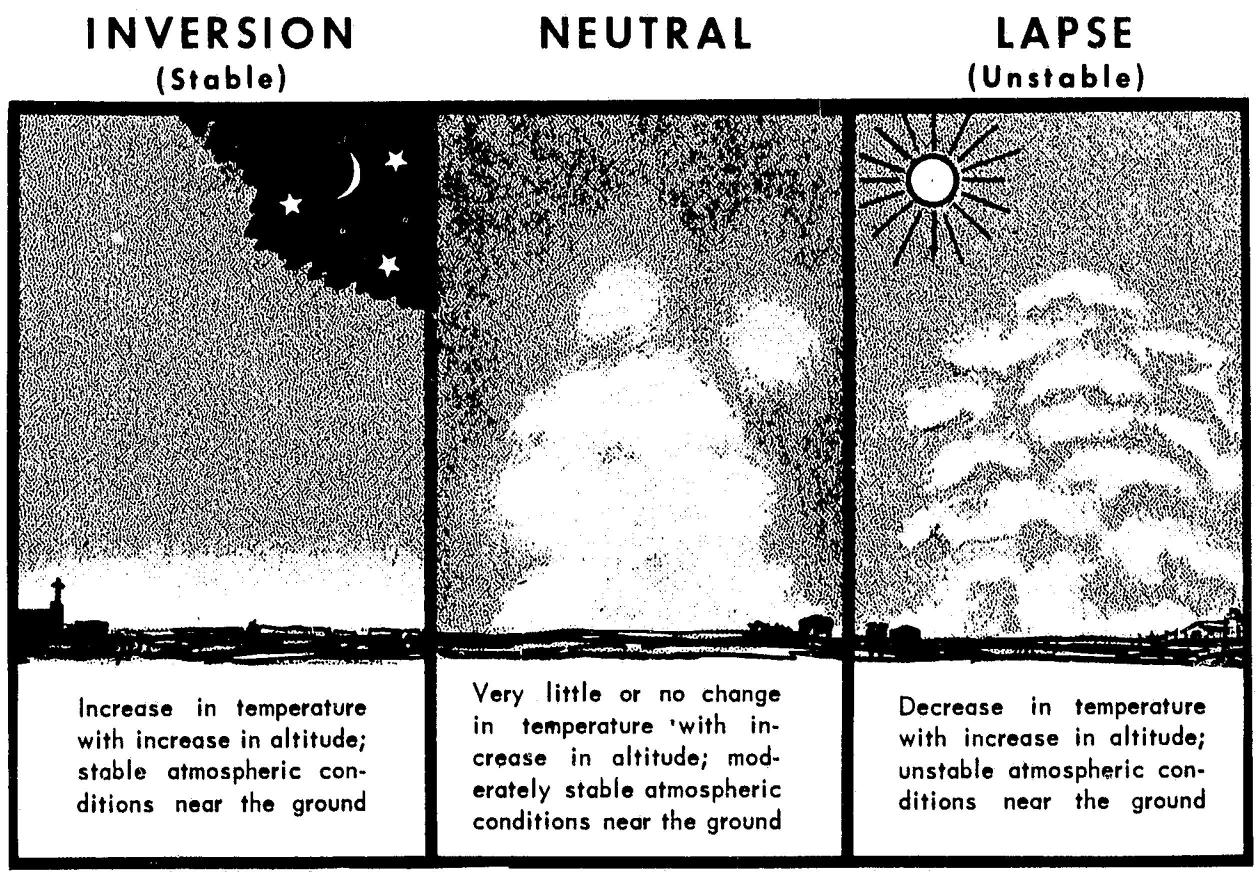


FIGURE 7 – VERTICAL TEMPERATURE GRADIENTS.
(DA Technical Manual TM 3-240, May 1963)

Lapse (Unstable) Condition (Figure 7). A decrease in air temperature with increase in height is known as a lapse (or unstable) condition. A lapse condition usually prevails during daylight hours if the sky is clear or partially clear. Under this condition, the rate of vertical temperature decrease is most rapid close to the earth's surface, becoming slower as the height above the ground increases. Lapse conditions are characterized by turbulence from thermal currents. Agent clouds released under these conditions tend to be quickly dispersed. The mechanical turbulence caused by winds above 10 to 12 miles per hour tends to prevent the formation of strong lapse conditions.

Inversion (Stable) Condition (Figure 7). An increase in air temperature with increase in height is known as an inversion (or stable) condition. An inversion condition usually prevails in the lower layer of air on clear or partially clear nights and early mornings until about 1 hour after sunrise. Inversion is accompanied by a minimum number of convection currents and maximum stability. Because inversion conditions tend to resist

and suppress vertical air currents, such layers are said to be stable. The mechanical turbulence caused by winds above 6 to 8 miles per hour tends to prevent the formulation of strong inversion conditions. Under an inversion condition when wind speed is below 5 miles per hour, smoke or chemical clouds have a more persistent effect than under a neutral or lapse condition. With fairly low but steady wind, chemical agent clouds travel without excessive diffusion.

Neutral Condition (Figure 7). A condition intermediate between lapse and inversion is known as a neutral condition. A neutral condition indicates a vertical temperature gradient between plus 2° F. and minus 2° F. between 1 and 6 feet above the ground. This condition exists when all the lower levels of air (up to 6 feet) are approximately the same temperature. Unlike its action under inversion, air in this condition neither resists nor encourages vertical displacement and turbulence. A neutral condition usually prevails on heavily overcast days or nights and during the crossover periods that occur 1 to 2 hours before sunset, when lapse (unstable) conditions normally begin to change to inversion conditions, and 1 to 2 hours after sunrise, when inversion conditions normally begin to change over to lapse conditions. (Figure 8). A neutral condition is accompanied by relatively few convection currents. Smoke or chemical clouds released under this condition remain fairly effective, provided that the wind speed is not too high.

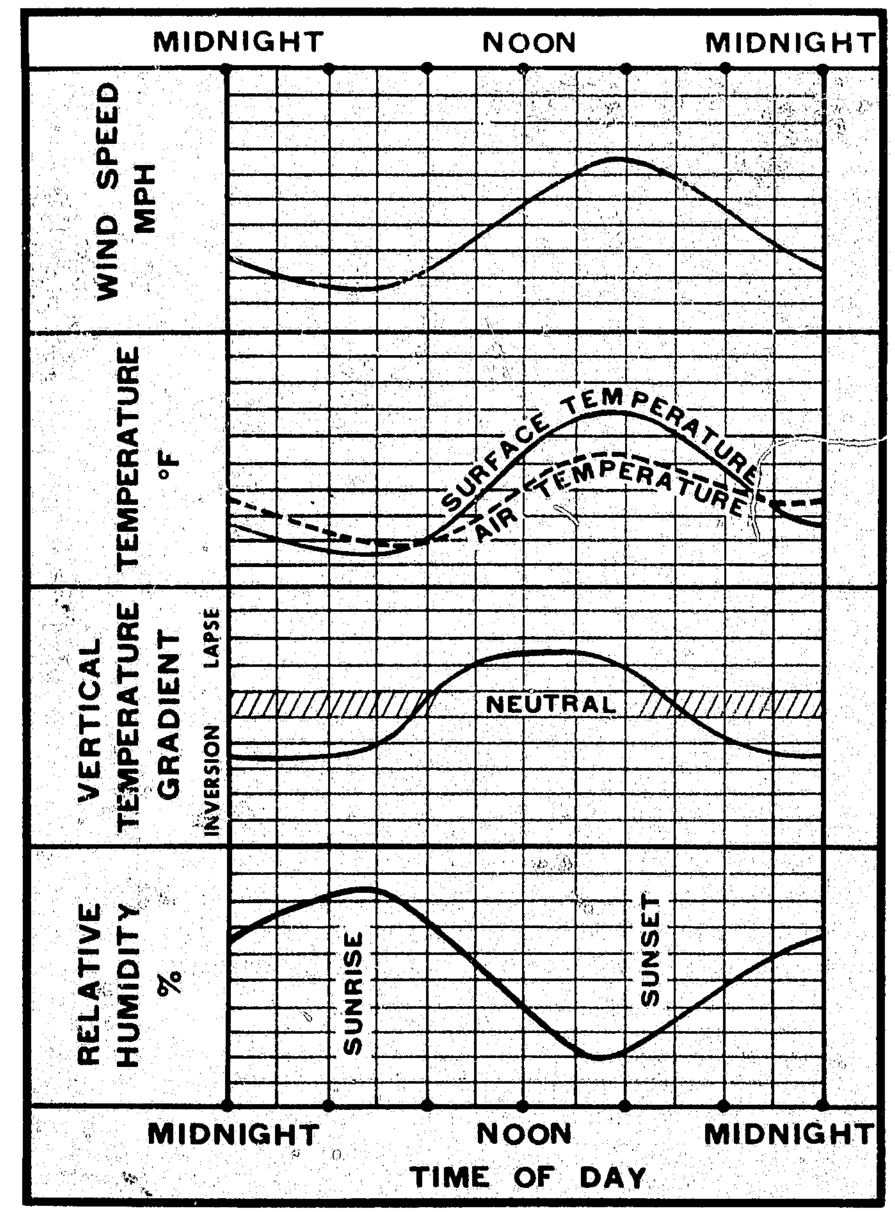


FIGURE 8 – NORMAL DAILY VARIATIONS IN WEATHER CONDITIONS WITH REFERENCE TO LOCAL TIMES OF SUNRISE AND SUNSET.
(DA Technical Manual TM 3-240, May 1963)

The relationship between thermal gradient and agent concentration was recently stated by Richard E. Reinnagel of Cornell Aeronautical Laboratory, Inc., in the following way:

> The area covered by a single source is greatly dependent upon the meteorological conditions, particularly the thermal gradient, that is, neutral, inversion, or lapse. For neutral conditions, that is a zero degree vertical temperature gradient, the cloud will diffuse linearly in the vertical and cross-wind direction, with the downwind concentration decreasing approximately as the square of the distance from the source. For the extreme lapse condition (lower temperature as height above ground increases), the concentration decreases approximately as the fourth power of the distance from the source by virtue of the considerable vertical diffusion, and for the inversion condition, the concentration decreases approximately as the 3/2 power of the distance from the source. The significance of this is shown in Figure 9.[1]

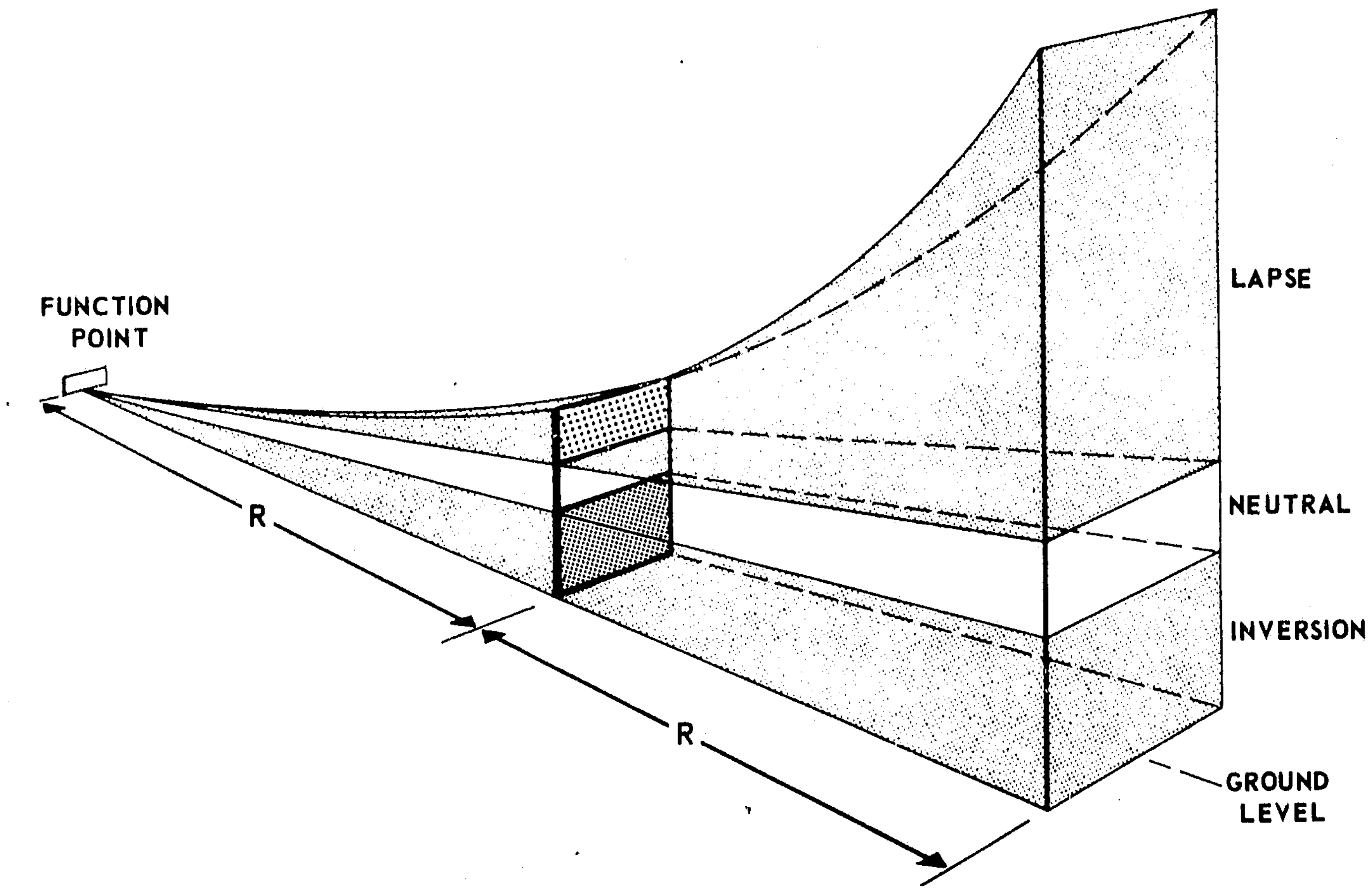


FIGURE 9 – EFFECT ON THERMAL GRADIENT ON CONCENTRATION
(Considerations in the Use of Irritants in Law Enforcement, August, 1968)

What all of this means from a practical point of view is that more munitions will be required to provide a given chemical agent concentration on the target area under lapse conditions than when neutral or inversion conditions prevail. It also suggests that higher than intended concentrations might inadvertently be produced under inversion conditions. The ideal condition, then, would be an inversion state and a 5-10 mile per hour following wind if the objective is to cover a maximum area with a minimum of munitions.

c. *Humidity / Precipitation*. While humidity itself does not seriously affect riot control chemicals, the smoke particles produced by pyrotechnic munitions tend to absorb moisture and increase in size, giving the appearance of greater density. When both relative humidity (the ratio of the quantity of water vapor that the air actually contains to the quantity of water vapor it would contain if it were saturated) and temperature are high, personnel tend to perspire more freely, thereby increasing the severity of skin irritation symptoms.

[1] Reinnagel, Richard E., *Considerations in the Use of Irritants in Law Enforcement*, August 1968

Heavy or steady precipitation tends to sharply limit the effectiveness of riot control agents of all kinds in that the aerosol cloud is simply washed out of the air before it has had an opportunity to produce the desired effects. Should it become necessary to employ chemical agents in the rain, the munitions expenditure level would be extremely high.

In the unlikely event that projectiles or grenades were to be employed in snow covered areas, it should be anticipated that their effectiveness would be sharply reduced, again resulting in a high munition consumption rate. Under such conditions bulk dispensers or air bursting expulsion grenades would be preferred.

2. MUNITION CHARACTERISTICS

a. *Particle Size*. As discussed in an earlier publication, riot control chemical agents are disseminated primarily through the use of either pyrotechnic or expulsion devices. In either method, the chemical agent reaches the target in an aerosol state. The size of the agent particles in the cloud has a direct relation to the effectiveness of the concentration since they must be light enough to drift with the air for reasonable distances and be present in sufficient quantity to produce uniform irritation over exposed skin areas.

On the other hand, particles must be large enough to provide adequate impaction efficiency and resist sublimation or excessive dispersal. It is generally agreed that in order to be effective, agent particles should be at least 0.5 micron and not larger than 15 microns in size, with the most desirable size around 2 microns.

Particle size is also one of the factors involved in determining the persistency of a particular concentration. The larger particle sizes produced by the expulsion devices are more contaminating than the sub-micron particles found in pyrotechnic dissemination and the newer liquid fogging devices appear to be the least contaminating of all.

b. *Diffusion*. When chemical agents are released into the air, they form a cloud that drifts with wind currents. The shifting nature of air currents causes the cloud to spread out as it moves downwind. Under normal conditions with a constant wind, the agent cloud will expand about 20% of the distance traveled from the release point (Figure 10). As previously indicated, wind speed, turbulence, and temperature all play an important part in the rate of diffusion of the agent cloud.

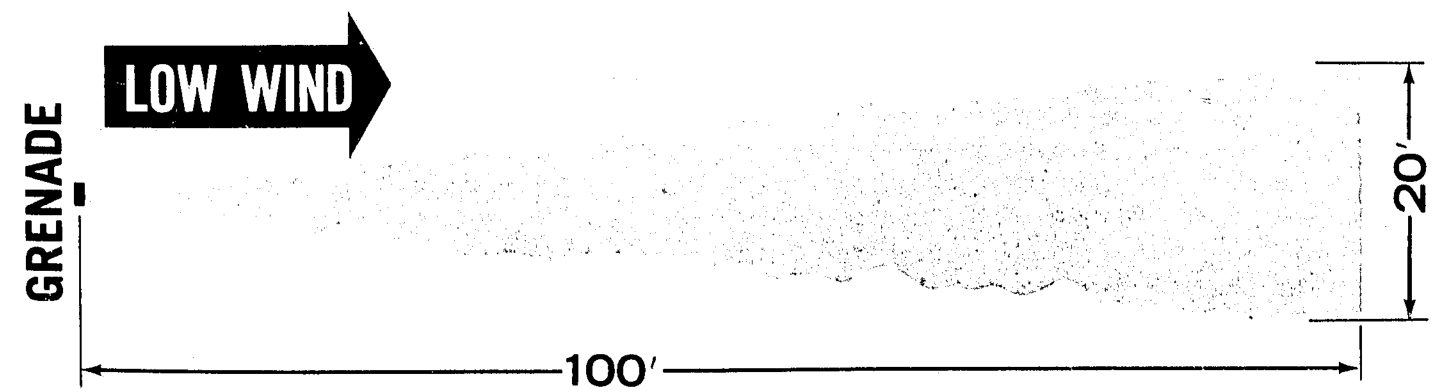


FIGURE 10 – LATERAL SPREAD OF THE AGENT CLOUD UNDER NORMAL CONDITIONS

In the case of pyrotechnic munitions, vertical rise as a result of the burning process also contributes to the diffusion of the agent concentration. However, since the particles are heavier than the surrounding atmosphere, the cloud tends to settle again once it has cooled.

[1] A micron is about 1 / 25,000 of an inch.

The dynamics of agent cloud behavior are of particular importance when considering the area coverage produced by single point release devices such as the grenade or projectile. In the paper referred to earlier, Reinnagel concludes that currently available single release munitions are improperly designed for efficient area coverage and suggests that what is needed instead are a number of smaller, but more uniformly distributed devices. He writes:

> Increasing the size of a single source does not greatly assist in covering an area since the tendency is toward a higher concentration over the same area, with the further disadvantage of generating undesirably high concentrations in the vicinity of the source. . .
>
> Figure 11 shows the influence of source size on the area covered to a given concentration. We see that three 5-gram sources produce the same minimum useful concentration as one 100-gram source, and avoid the heavy over-concentration which results from one large source.

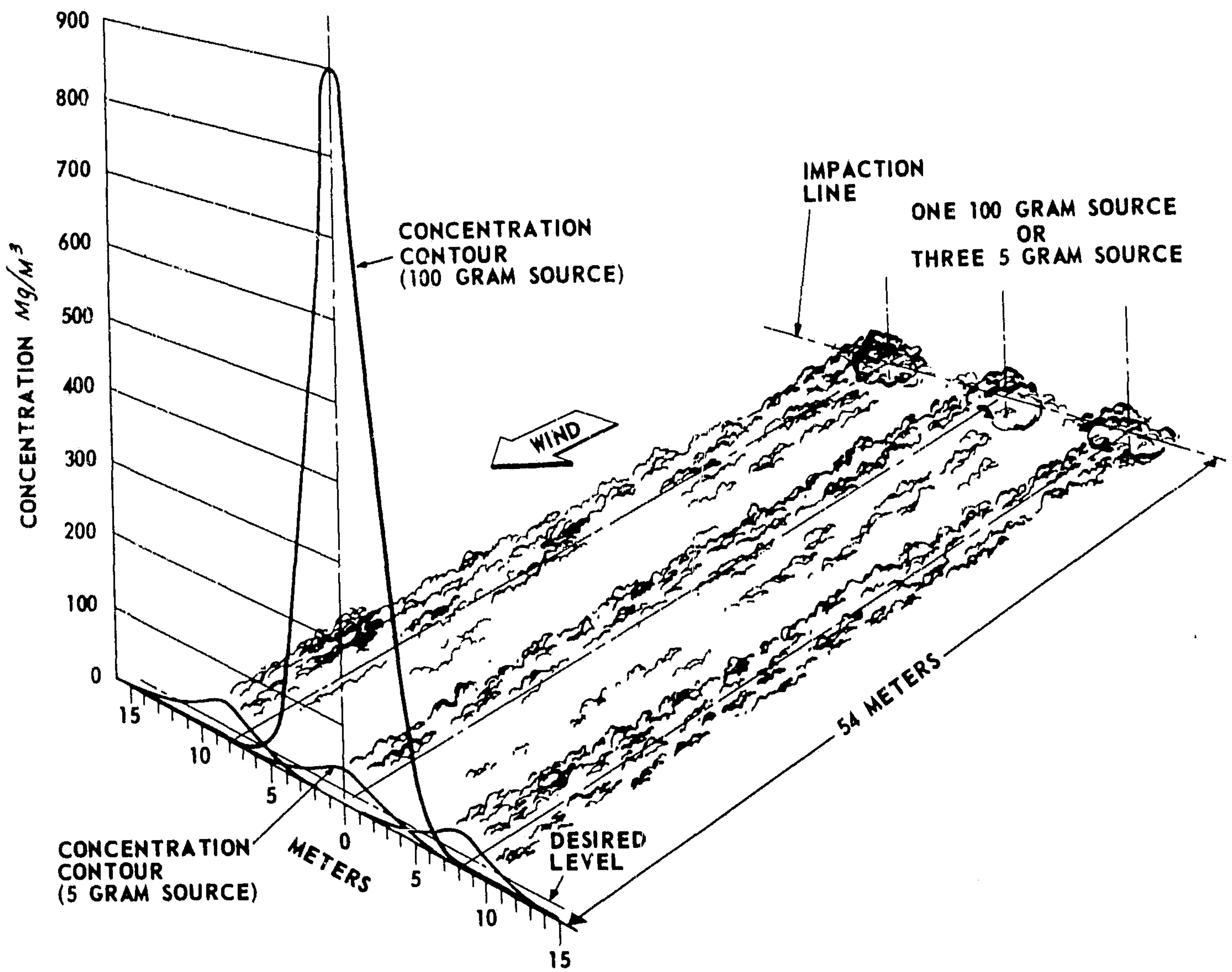


FIGURE 11 – DOWN WIND CONCENTRATION AS RELATED TO SOURCE SIZE
(Considerations in the Use of Irritants in Law Enforcement, August, 1968)

3. **TARGET NATURE.** Since chemical agents are employed against people instead of inanimate objects, the effectiveness of such operations is always dependent to at least some extent on the nature of the target individual or group. The rate of breathing, for example, is an important factor in determining the speed and severity of symptoms produced by a chemical agent. The rate of breathing is, in turn, dependent upon the

state of excitement or activity level of the individual. Personnel breathing deeply as the result of exertion or emotion are likely to be affected by agents more quickly than are more tranquil persons.

While tests to date have indicated that little or no tolerance is developed to CS, it is obvious that experience and knowledge about the agent tend to reduce the fear of the unknown that provides an added psychological advantage when agents are employed against inexperienced and uneducated subjects. It is only logical to anticipate that chemical agents will lose at least some of their advantage in riot control as they become more widely used and understood.

Short of masking, however, there are no effective defensive measures that can be taken against a well planned and executed chemical agent deployment. Surplus and other protective masking equipment presently in the hands of dissident groups in the United States is insufficient for large scale civil disorders, but in all probability is adequate to support limited operations of a hit-and-run nature.

TACTICAL OBJECTIVES

With a general understanding of the nature of chemical agents and those factors that govern their effectiveness, it only remains for the police field commander or chemical agent officer to apply this knowledge to specific tactical situations. While the tactical objectives achievable through the use of chemical agents are, at least in theory, almost unlimited, modern law enforcement experience suggests that most applications fall into one of the general categories discussed below. In each case it is assumed that the underlying philosophy involved in the use of chemical agents is to minimize unlawful behavior and the level of force or violence required to deal with such conduct. The punitive application of any chemical agent is inconsistent with the role of the police in a democratic society and certainly not a legitimate objective within the scope of this discussion.

Large Groups. Almost all existing police chemical agent doctrine deals with the classic situation wherein the need arises to disperse large numbers of people who have assembled or are moving in an illegal manner. In situations of this sort, the objective is normally to disperse the crowd and/or cause it to move in a desired direction; usually away from critical installations, high value shopping areas subject to looting, or locations where the disorder may be intensified.

Against large crowds, chemical agents are normally employed in a manner designed to cover the entire target area with a simultaneous cloud of sufficient concentration to produce the desired effects. In accomplishing this purpose, it is necessary to think in terms of a release line that allows the agent to reach the crowd in the desired concentration. (Figures 12A, 12B and 12C). The release line must be selected in relation to the wind direction and speed and, whenever possible, should be protected against crowd personnel who may attempt to kick or throw back pyrotechnic grenades or physically assault officers who are operating bulk dispensers. Since it is not unusual to find that personnel can run for distances up to 20 or 25 yards before being fully affected by chemical agents, especially when CN is being used, the line at which a uniform concentration is established (conversion line) should be located at least that distance from the target group.

Also to be considered in the selection of a release line when grenades are being employed is the need for uniform target area coverage. Assuming a normal following wind, 5 to 10 miles per hour, the output of burning munitions will expand about 20% of the downwind distance traveled. Thus the agent cloud produced by grenades placed 5 yards apart on the release line will converge at about 25 yards forward of the release point. (Figure 13).

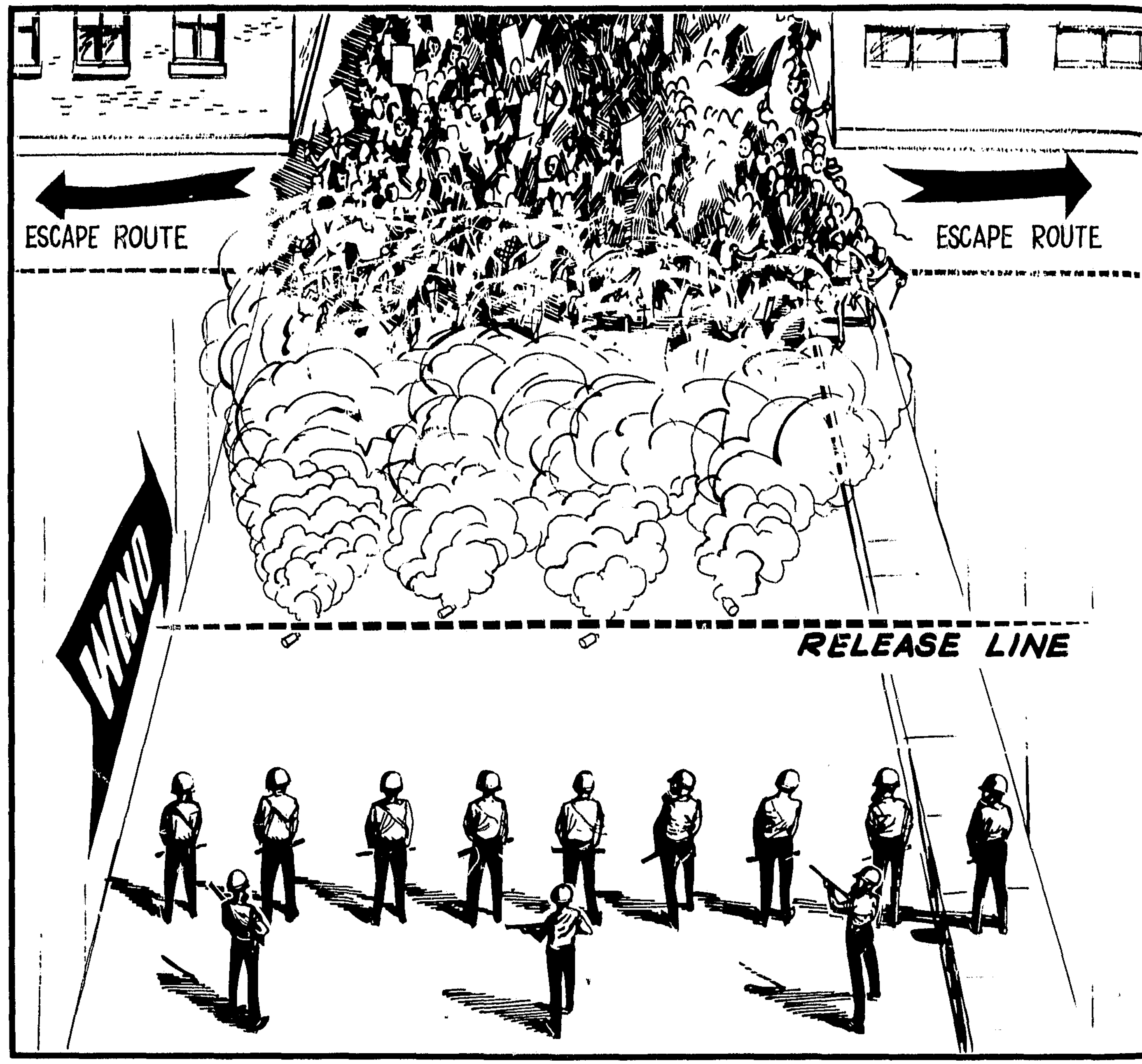


FIGURE 12A – IDEAL RELEASE PATTERN – FOLLOWING WIND
(Grenades or Bulk Dispenser)

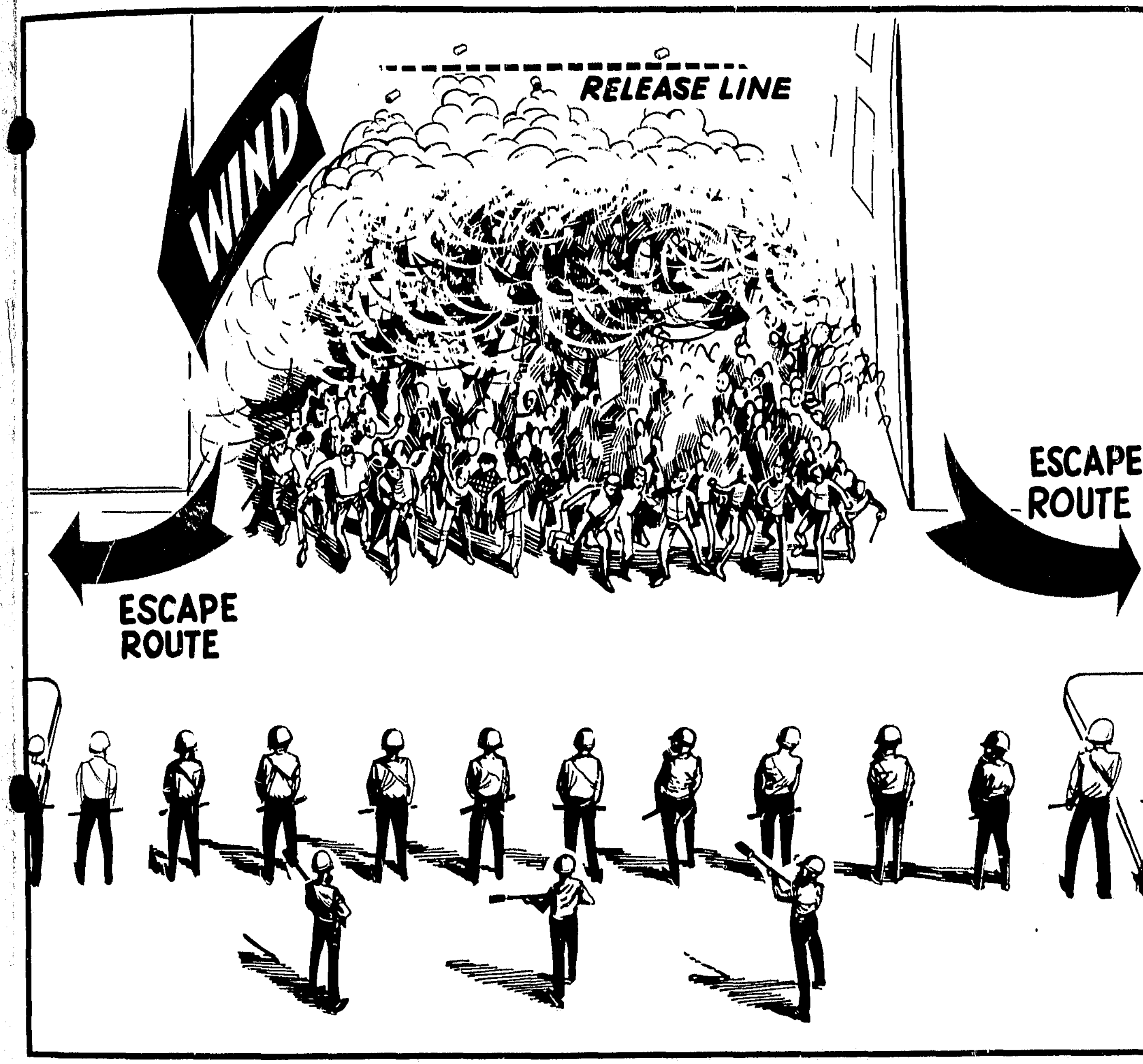


FIGURE 12B – IDEAL RELEASE PATTERN – HEADWIND
(Launched Grenades of Unstabilied Projectiles)

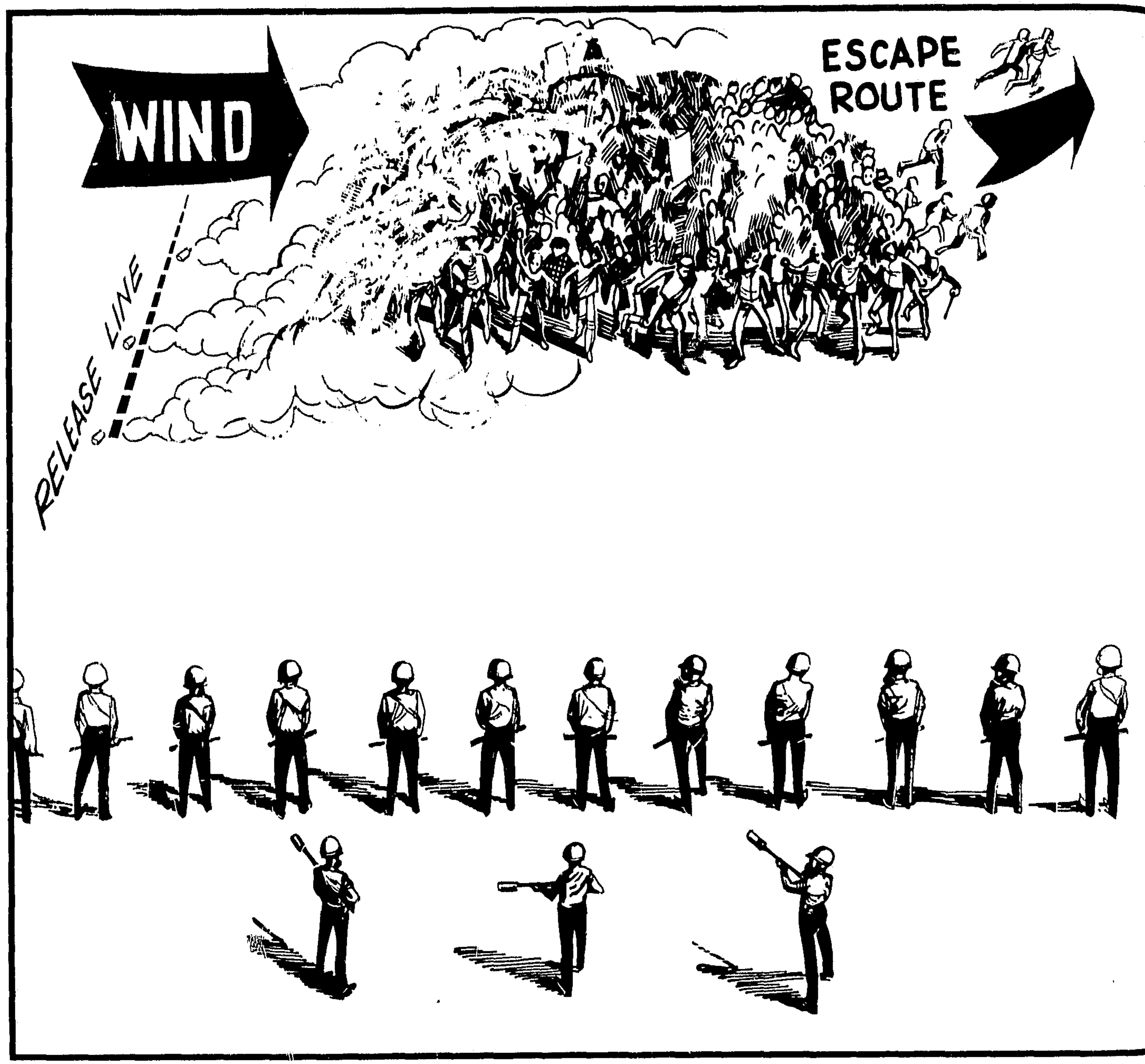


FIGURE 12C – IDEAL RELEASE PATTERN – FLANKING WIND
(Launched Grenades or Unstabilized Projectiles)

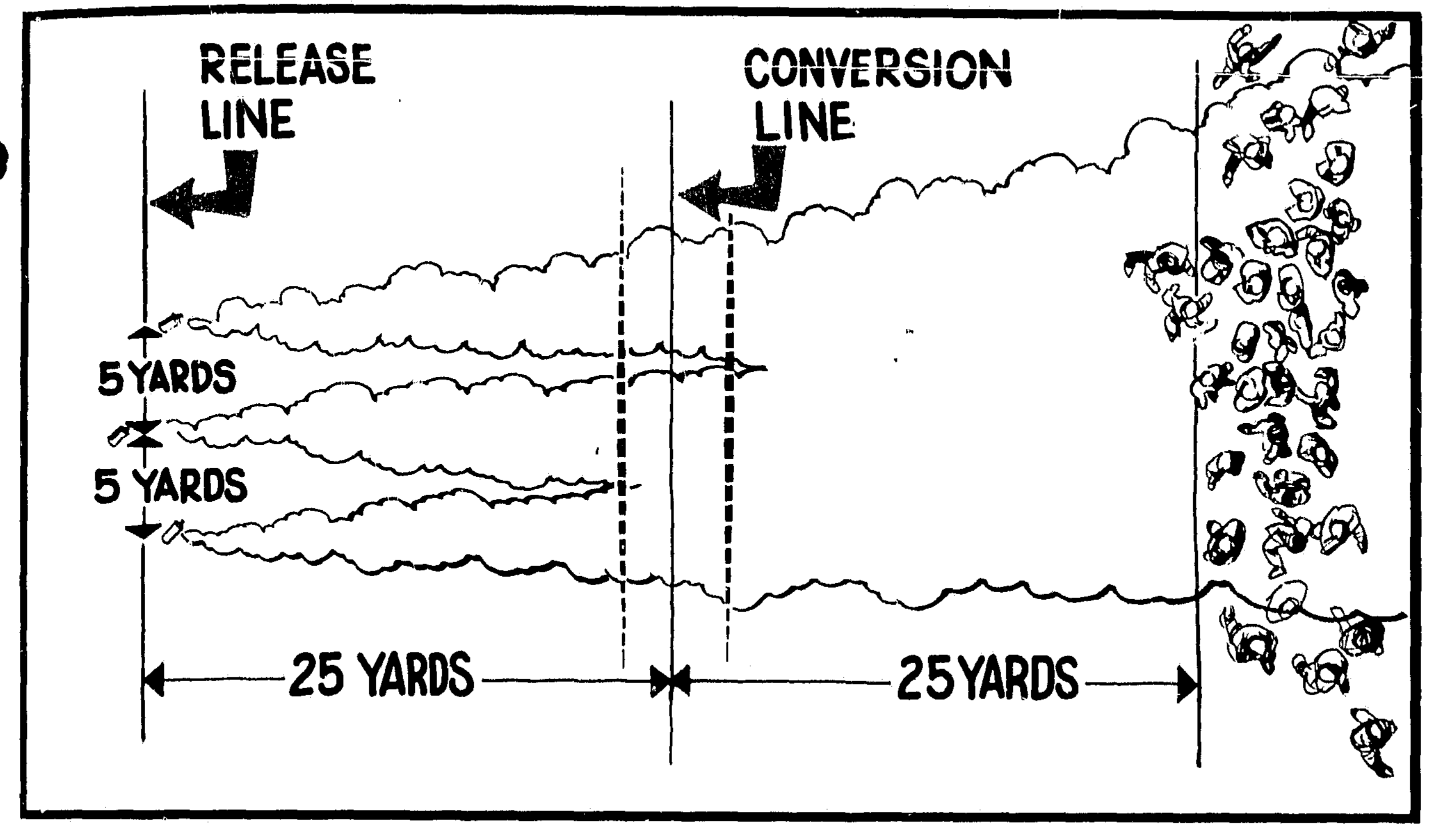


FIGURE 13 – IDEAL RELEASE LINE/TARGET RELATIONSHIP

Once the desired concentration has been established, sufficient munitions must be employed to maintain the concentration until the crowd has been dispersed along the pre-selected escape routes that should always be left open. The number of munitions required in any situation depends upon many variables, including temperature gradient, wind speed, wind direction, and munition design. As a rough guide, however, the Army suggests that their M7A2 and M7A3 burning grenades can be expected to cover, in a 9-15 mile per hour wind, an area of about 109-164 square yards. As a further rule of thumb, the Army estimates that with a following wind perpendicular to the release line with an average favorable wind speed, burning munitions' requirements will be roughly as indicated in Figure 14. To maintain a concentration, munitions will have to be replaced as fast as they burn out, about every 40-150 seconds for standard pyrotechnic grenades. Military and civilian standard pyrotechnic grenades are sufficiently similar in performance characteristics that Army munitions requirement estimates can be used as a rough guide in planning civilian chemical agent operations.

FIGURE 14 – MINIMUM PYROTECHNIC GRENADE REQUIREMENT ESTIMATE

Release Line Length	**Number Munitions Required***	**Width of Cloud 250 Meters Downwind****
Point	4	50
25 Meters	6	75
100 Meters	20	150
250 Meters	40	300

* Distributed evenly along release line and fired simultaneously.
** Average favorable following wind

In the case of bulk dispensers, the concentration is produced by moving the dispenser along the release line at an even rate. The concentration is maintained by simply repeating the application as necessary. Bulk dispensers provide the most economical method for generating the large volumes of agent required for use against crowds, but their utility is unfortunately limited by the fact that they can be employed only with a following wind or at close range in conditions of relative calm.

Although pyrotechnic grenades and bulk dispensers are the munitions usually employed against large crowds, separating or expulsion grenades are often integrated to discourage rioters from attempting to return the standard burning grenades or for psychological effect. When they are employed, explosive munitions should be used in a manner to minimize the risk of injury.

When working into a headwind, police must place munitions behind the crowd through the use of unstabilized projectiles or grenade launchers. Under such conditions it is more important than ever that clear escape routes be provided to prevent the crowd from rushing blindly into police lines in an effort to escape the agent concentration.

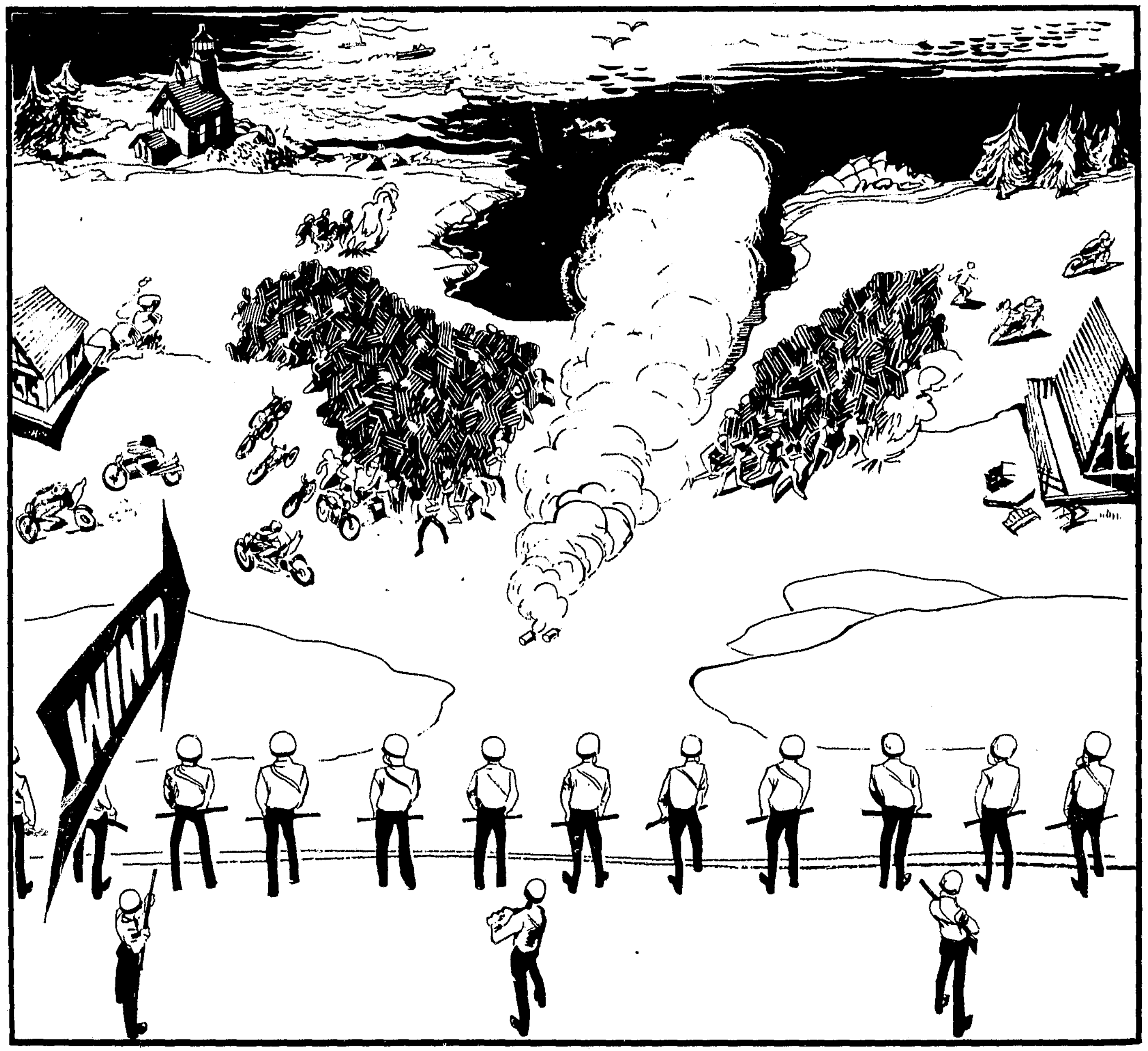


FIGURE 15 – USE OF AGENT TO SPLIT A CROWD UNDER FAVORABLE CONDITIONS

As is the case with almost all situations where riot control agents are used, deployment against large crowds requires a follow-up plan to exploit the temporary advantage gained by a well planned and executed chemical operation. Depending of course upon specific tactical objectives, it is usually desirable to move immediately into the target area with masked personnel to disperse lingering groups and to pursue the crowd to prevent regrouping or further illegal activity. During mop-up operations police officers should be alert to render prompt assistance to persons unconscious or incapacitated in the contaminated area.

Occasionally, it may be desirable to split a large crowd rather than to engulf it completely in an agent cloud. This can be accomplished through the release of agent at a specific point if wind conditions are favorable (Figure 15). This tactic will only be effective against crowds that are acting under minimal motivation and unless the split is quickly exploited by maneuver, it will probably be necessary to employ additional agent to prevent the crowd from regrouping or turning on the police lines.

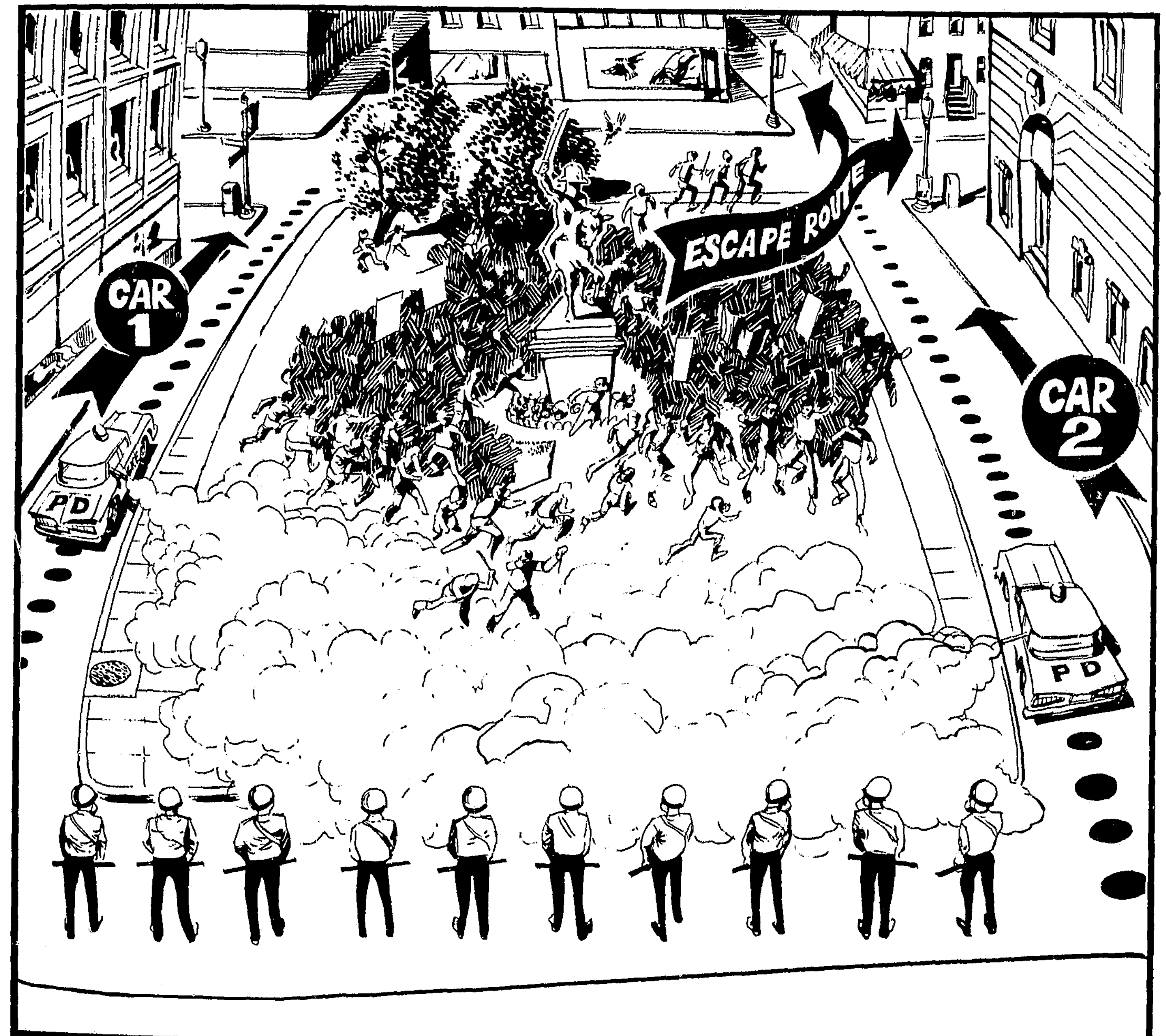


FIGURE 16 – RAPID AREA SATURATION WITH VEHICLE MOUNTED FOG DEVICES

Cities being what they are, most police confrontations with large groups take place either on narrow streets or in park areas that simply do not lend themselves to the procedures called for in the traditional doctrine advocated for the use of chemical agents against large groups of people. Wind direction and working distances, for example, are seldom satisfactory and the proximity of homes, hospitals and businesses may well preclude the release of large quantities of chemical agent. In such cases it may be necessary, even if less desirable tactically, to use low output burning or expulsion munitions to break a crowd up into smaller groups that can then be further dealt with through the use of riot control formations.

Under certain conditions, the low contamination fog dissemination devices can be used to quickly engulf large areas with a characteristically buoyant chemical agent fog that dissipates rapidly. By operating the fog device from a moving vehicle it has been possible to clear several square blocks or a small park area by driving the agent dispersing vehicle through or completely around the target area (Figure 16). Obviously this tactic will be feasible only in those instances where vehicles can safely be operated throughout the area and the necessary security can be provided.

FIGURE 17 – IMPROPER USE OF PYROTECHNIC GRENADES IN A CONTACT CONFRONTATION

Perhaps the most difficult confrontations with large crowds occur in those situations where the police find themselves positioned in almost direct contact with the crowd at the time action is initiated. If a decision is made to use chemicals there is always a strong temptation to throw burning grenades into the mob, a practice that generally results in the return of the grenades or the driving of the front ranks of the crowd into the police. (Figure 17). Here again, the use of bulk dispensers, especially the fog dissemination type, should be considered if conditions favor their use from behind police lines.

To point out the limitations inherent in traditional doctrine for chemical operations against large groups is not to suggest that such tactics are completely irreleverent to modern riot control. The underlying principles are valid and an understanding of these basic concepts will enable police field commanders to make appropriate adjustments under a variety of tactical conditions.

Small Groups. Recent civil disorders in the United States have shown an increasing use of chemical agents to disperse small groups of persons involved in unlawful conduct. Small groups of 25 to 50 people may frequently gather during disorders and throw objects at cars or congregate near stores that have been partially looted. In such situations, roving police units can employ low volume grenades to break up these small gatherings and, at least temporarily, prevent further misconduct. (Figure 18).

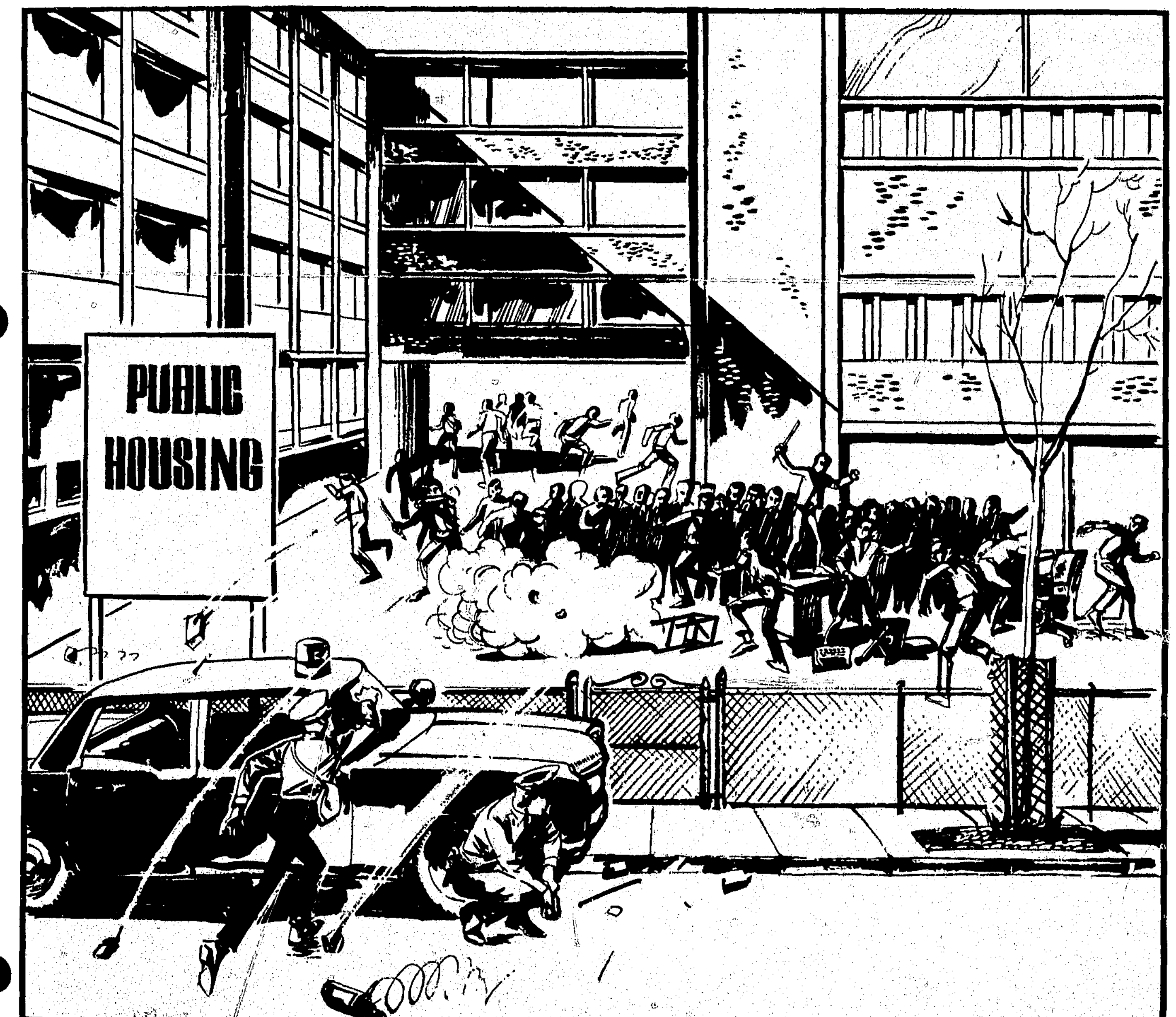


FIGURE 18 – USE OF GRENADES AGAINST SMALL GROUPS

This low volume use of agent to accomplish a temporary objective enables a few officers to disperse a group without calling for additional manpower and equipment, a step that often only tends to attract more persons to the scene and intensify the nature and duration of the incident. This limited application of chemical agent must, of course, be preceded by a careful assessment of the composition and mood of the target group. In those cases where such a group is highly motivated and inclined to violence, the use of a small amount of agent may only provoke an attack on outnumbered police personnel.

When conditions favor the low volume application of chemical agents, the new miniature pyrotechnic grenades (Figure 19) are extremely effective. These devices produce a concentration that is sufficient to achieve the objective, but small enough to reduce substantially the risk of contaminating nearby homes or other facilities. With the use of a universal launcher, the Lake Erie miniature grenade can be accurately fired for distances up to 100 yards from the standard service revolver or riot shotgun. At short distances, the 1.5 caliber muzzle blast cartridges may also be effectively employed against small groups.

DESIGNATION	ACTIVE AGENT LOAD (GRAMS) CN	CS	BURNING TIME (SECONDS)	TOTAL WEIGHT (OUNCES)
Brunswick Skitter Grenade	16	16	10-20	5
Federal Pocket Grenade	17	20	16	6
Lake Erie Mighty Midget	17.5	14	10-15	4

FIGURE 19 – LOW VOLUME PYROTECHNIC GRENADES FOR USE AGAINST SMALL GROUPS

Expulsion grenades rolled into small groups will generally dump most of their agent load on the ground, reducing even further the airborne drift of agent, a feature that might, in this situation, be desirable. The noise of the explosive discharge produced by many of the expulsion devices will also assist in scattering most groups.

It should also be pointed out that what is suggested here is the use of chemical agents against small groups engaged in unlawful behavior during periods of civil disorder, not the routine use of chemical munitions under relatively normal police operations.

Snipers and Barricaded Criminals. The problem posed by the barricaded sniper is one of the most difficult tactical situations confronted by law enforcement officials. Whether encountered under riot conditions or in normal police operations, the sniper operating from within a residence or public building presents a clear and present threat to human life. Consequently, police operations should be designed to deal with the sniper in a manner that will minimize, rather than increase, the potential for injury or death to innocent personnel.

Without attempting to discuss in detail the emerging doctrine for anti-sniper operations conducted by civil police in the United States, it is still possible to identify the essential basic principles involved and to consider the ways in which chemical agents might be usefully employed.

Four steps involved in almost all types of anti-sniper operations can be considered under the key words:

- **LOCATE**
- **ISOLATE**
- **EVACUATE**
- **ELIMINATE**

Location of the sniper, particularly under riot conditions, can prove to be a difficult task. The erratic behavior of sound in an urban environment and the reduced visibility caused by darkness or smoke often combine to make target location a dangerous and time consuming process. To add to an already difficult situation, it can be assumed that, unless he is intent on self-destruction, the sniper will move regularly until he is trapped in a position from which be cannot escape. While easier to locate, the suicidal sniper, because of his willingness to maintain a rapid and continuous rate of fire, is probably the greatest threat to human life. In any event, the sniper must be located before any kind of effective action can be undertaken against him.

As a last resort in those cases where an active and accurate sniper cannot be pinpointed, the entire area may be covered with a screening smoke to limit his visibility and reduce casualty potential. The use of area screening will naturally further reduce the chances of spotting the sniper and will also facilitate his escape from the scene.

It would appear that technology is about to make a series of valuable contributions to the solution of sniper location problems. Presently available or under development are stabilized image binoculars, sonic sound location equipment, light amplification night vision devices, and even a system that will permit clear vision through screening smoke or chemical agent clouds.

Isolation of the sniper should begin as soon as his position is located and may even precede location in those cases where his general area of activity can be identified. Isolation simply involves sealing off all possible escape routes in an effort to insure the capture of the gunman if he attempts to leave the scene. The likelihood of success of the isolation process is in direct proportion to the accuracy of the location effort and the speed with which the maneuver can be completed. The smaller the area isolated, the better the chance for apprehension.

It may become necessary to employ screening smoke to enable isolation team personnel to complete their task. Again, however, smoke should be used only when absolutely necessary unless there is reason to believe that the reduced visibility will not facilitate the escape of the sniper or hamper the evacuation of innocent citizens.

Evacuation of the isolated and adjacent areas should be accomplished whenever tactical conditions permit. The removal of uninvolved personnel will not only insure their safety, but will greatly facilitate subsequent police action. Unfortunately, the evacuation of heavily populated high rise buildings may simply not be practical and police will have to conduct a search with the occupants in place.
Even though loudspeaker commands or even door-to-door notices have ordered evacuation from a building, it should never be assumed that *all* innocent personnel have cleared the area. Experience has shown that some people will remain in their homes rather than follow police instructions, especially when they are frightened. In addition, many loudspeakers do not carry as well as expected and cannot be heard clearly inside a closed building.

Since there is usually a very good possibility that the sniper may attempt to join in with those evacuating the area, it is always a good idea to detain the evacuees in a nearby secure area or at least obtain some form of identification for future reference. While such protective custody may not always be feasible, it does provide for the safety of the displaced persons, insures their availability for subsequent investigation, and makes it easier to determine if the building has been completely cleared.

The *Elimination* of a sniper or barricaded criminal by apprehension should be accomplished whenever possible. Like mobs, barricaded gunmen differ in their psychology and level of motivation. Concern for life usually precludes a direct assault on subjects who have only threatened to shoot or who are holding hostages. In such cases, most police agencies have policies that call for location, isolation and evacuation, but stop short of direct attack as long as there is any hope that the subject can be taken without resort to deadly force.

On the other hand, once the sniper has opened fire in a manner that clearly indicates his intention to cause injury or death and when conditions suggest that such an outcome is likely, the police must take positive action to eliminate this threat by whatever means possible. Although the composition, equipment, and tactics of counter-sniper teams are beyond the scope of this discussion, there would appear to be several ways in which chemical agents can be used to assist in such operations.

First, stabilized chemical agent projectiles can be employed as soon as a sniper's location is determined. These devices can be fired with reasonable accuracy at distances up to 250 to 300 yards by personnel skilled in the use of the 1.5 caliber riot gas gun. Expulsion projectiles with impact fuzing are preferred, as the pyrotechnic round may cause fires or penetrate completely through a target room as a result of its considerable flight velocity.

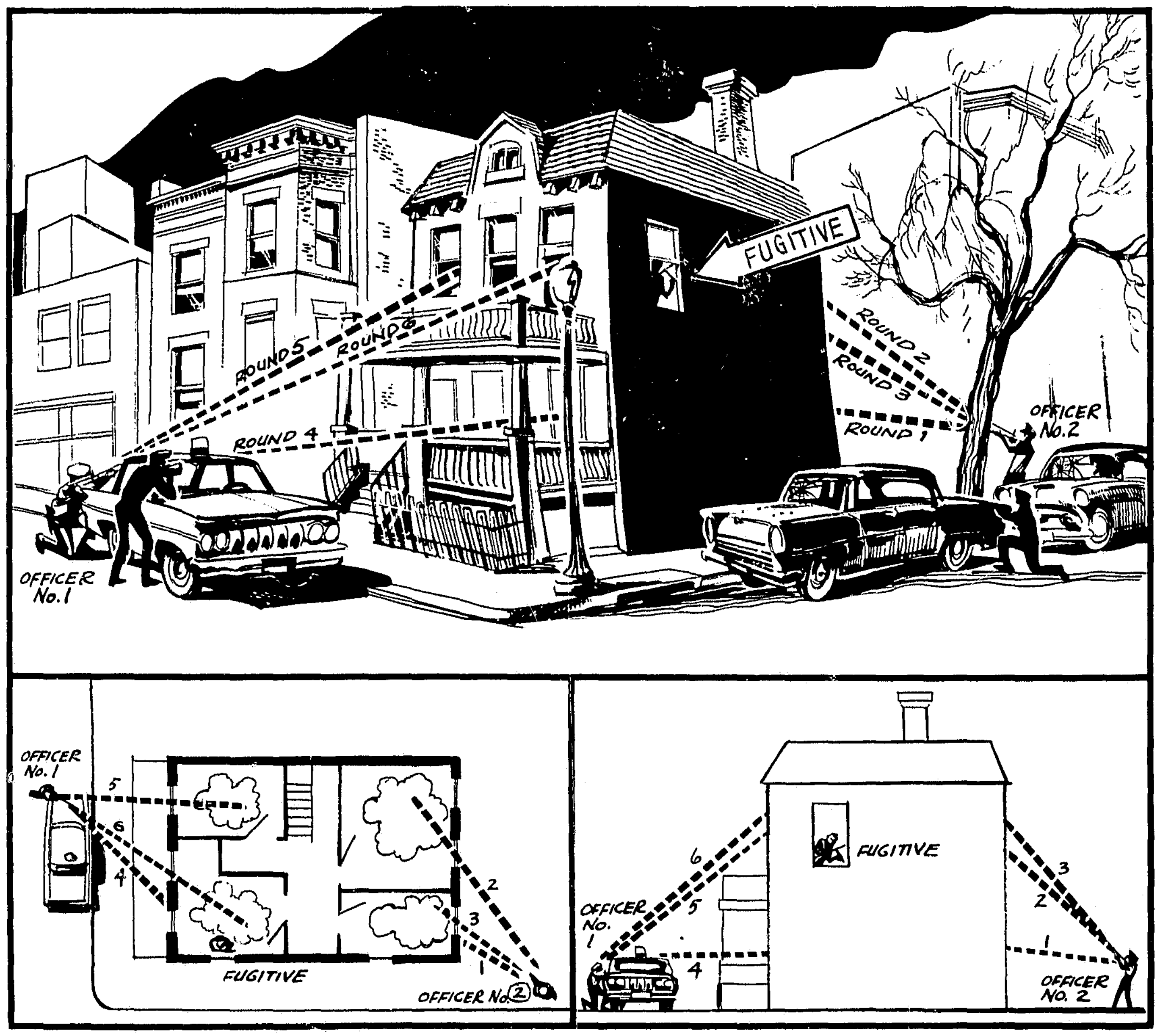


FIGURE 20 – USE OF PROJECTILES OR GRENADES AGAINST BARRICADED CRIMINAL
(Adapted from Federal Laboratories. Tear Gas Blue Book)

Launched expulsion grenades may be substituted for projectiles, but their accuracy and penetrating power are considerably less. At close range these characteristics are not as important and even hand delivered grenades can be effectively employed.

When the room occupied by the sniper is known, projectiles or grenades are usually fired into adjoining rooms first to prevent the subject's moving from room to room when his position is ultimately attacked directly with chemical agents. Since the objective is usually to drive the sniper from his secure position, it may be necessary to deny access to all rooms on a particular floor or dwelling unit. (Figure 20)

Once the sniper position has been hit with one or two units of agent, a short period should be allowed for the room to be completely engulfed. If the subject does not emerge it should be tentatively assumed that he is either unconscious or has moved to another location. Nothing constructive is gained by continuing to fire grenades or projectiles into a room already fully contaminated, especially when CS agent is being used.

While the chemical attack is under way, the tactical commander should remain alert to take advantage of every opportunity for maneuver to gain a more advantageous field position. The use of chemicals should be viewed as an integrated part of the operation, rather than as an isolated phase during which all other activity ceases. An effectively coordinated operation requires a high degree of fire control and communication that has, unfortunately, been lacking in too many past police encounters with barricaded subjects. Situations of this sort demand a level of teamwork and timing that cannot be achieved without constant training and practice under simulated conditions.

The continuing rash of fires resulting from police operations against barricaded positions suggests the need to again stress the caution against using pyrotechnic devices in any situation where the risk of fire is not acceptable. Even some of the expulsion devices can cause fires and police personnel should therefore be completely familiar with the characteristics of the munitions used by their department.

A *second* condition appropriate for the use of chemical agents arises under extreme conditions of civil disorder when an entire building must be searched for one or more armed snipers. In situations of this type, two man search teams are assigned, whenever possible, to search the building room by room, from top to bottom. By working downward, there is a better chance that snipers will be flushed from the building in an escape attempt rather than attempting to engage in a fire fight when trapped on upper floors.

When searching rooms that are likely to contain armed subjects, an expulsion grenade can be thrown into the room immediately prior to the entry of the search team. Ideally, the entry should be made at the moment the grenade detonates. (Figure 21) Advanced information regarding room layout is extremely helpful and should be obtained whenever conditions permit. Because of the property damage caused by the contamination resulting from the explosive dissemination of micropulverized agent, this technique is justifiable only under extreme conditions when the risk of serious injury or death is involved.

An alternative procedure, as yet untried under actual riot conditions, is suggested by the new fog dissemination devices. Because of the buoyant nature of the agent fog and its relatively low contamination potential, it is conceivable that a unit of this type could be used to clear an entire building from the ground floor. While this might flush the occupants upward, a condition not normally considered desirable, it could, under some conditions, be the safest way, or the only way, in which a building could be cleared.

Looting Deterrence. As a result of the civil disorders of April 1968, there developed a widespread belief that looting could be prevented by exploding CS grenades in stores. The concept behind this idea was that the micropulverized agent would remain either in the atmosphere or on the floor in sufficient concentration to make it extremely difficult or impossible for looters to enter the premises. In the case of agent deposited on the floors, it was presumed that the movement of potential looters would stir up sufficient airborne particles to produce a full range of incapacitating effects.

Unfortunately, neither theory nor practice supports the concept of preventive contamination. Once the initial airborne concentration has settled, only a great deal of motion will produce the kind of re-activation envisioned and persons willing to suffer minor irritation could, in all probability, remain in the building long enough to seize valuable merchandise. On the other hand, it is quite clear that any heavy CS concentration will destroy the value of most merchandise and present serious decontamination problems.[1] Pending further research and field experience, police planners should regard with caution claims that CS agent in the amount contained in standard expulsion munitions will deter any determined looter once the initial concentration has settled.

Sit-In Demonstrations. Chemical agents can, if carefully employed, be used to clear demonstrators from buildings or other places of unlawful assembly. When used to drive occupants from a building, the agent should be applied in a controlled release, with only the concentration needed to produce the desired results being generated. The chemical wand is particularly suited to this application, as are also some of the fog generators. Because of the nature of sit-in demonstrations, the police must use extreme care to avoid causing any personal injury or giving the impression that unnecessary force is being employed. In situations of this type, the demonstrators frequently hope to provoke the police into some form of over-reaction that will gain sympathy for the protestors and their cause or at least attract additional news media coverage.

FIGURE 21 – USE OF EXPULSION GRENADE IN ROOM SEARCH

[1] There is also reason to believe that at least some "arson" losses were the result of the erroneous use of pyrotechnic grenades to "prevent" looting.

When agent is released in a building to break up what is essentially a non-violent demonstration, it is absolutely necessary that adequate exits be left open and that demonstrators be directed out of the premises to prevent accidental injury. Agent should be introduced on the highest floors occupied and gradually moved downward toward the ground floor. The application of agent on lower floors first may cause personnel on upper levels to attempt to jump or climb from windows, a practice that is potentially dangerous and which provides the news cameraman with dramatic footage in support of claims of police use of unreasonable force.

In dealing with the non-violent demonstration it is essential that the police proceed in a calm and orderly manner designed to create the impression of impartial professionalism. Any display of temper or unnecessary violence only plays into the hands of demonstrators by alienating the support of previously uninvolved spectators and the public at large. Since it is desirable to avoid personal injury, property damage, and the creation of a "spectacular" event, the use of projectiles or grenades inside a building should be avoided. Likewise, high volume bulk dispensers are generally unsatisfactory.

Because the tactical objective is normally to clear the building with a minimum of excitement and outward effect, a controlled dissemination device is preferred. The CS Chemical Wand delivers a steady, low concentration cloud of smoke and agent over a period of up to 4 or 5 minutes duration. The wand can be ignited and carried into a building for whatever length of time necessary to cause evacuation.

Self-Defense. Chemical agents, particularly as disseminated by the aerosol irritant dispensers, are an effective alternative to greater levels of violence in those instances calling for self-defense or the arrest of a belligerent offender. Although the aerosol irritant projectors are discussed in a the next chapter, their limitations in crowd control situations should be noted.

No legitimate police objective can be achieved by the indiscriminate spraying of irritant projectors into the front ranks of a large crowd. Such a practice only results in the temporary incapacitation of those within range of the weapons, who then are trapped between police lines and the forward motion of the crowd. The risk of serious injury is high, with no commensurate tactical advantage realized.

Portable back-pack liquid mist projectors designed to disseminate a highly effective irritant that is less severe than the current CS and CN liquid formulations are in the advanced stages of development. These devices, which were built in response to the area contamination problems encountered during the Chicago Democratic Convention disorders, may provide a selective and low risk answer to the problem of dealing with large mobs at close quarters. In the meantime, the standard CN and CS aerosol irritant projectors should not be employed for this purpose.

CHAPTER FIVE

Aerosol Irritant Projectors

Aerosol irritant projectors, one of the most widely used and discussed nonlethal weapons to emerge for police use, were conceived and developed in order to provide law enforcement officers with an alternative to traditional weapons such as the nightstick or firearm. Generally speaking, the projectors have proven to be extremely useful police tools when properly used and when their function is understood. Although no accurate count is available, more than 250,000 projectors have been marketed by just one of several manufacturers in the United States and field experience suggests that there are a large number of American law enforcement agencies presently utilizing aerosol irritant projectors.

Considering the widespread use of the aerosol irritant projectors, there would appear to be an alarming amount of misinformation and confusion surrounding the nature of these non-lethal weapons. The popular press and manufacturers have often been less than accurate in their descriptions of the projectors and police officials have compounded the problem by frequently failing to provide their personnel with even the minimum necessary training in how and when to employ such devices. Add to this situation a small but vocal group of citizens who have, for various reasons, attacked the police use ofchemical weapons and the need for a greater understanding of the aerosol irritant projectors on the part of law enforcement personnel at all levels is apparent.

It should be understood at the outset that these devices are weapons -- nonlethal weapons, true, but with the emphasis on weapon.

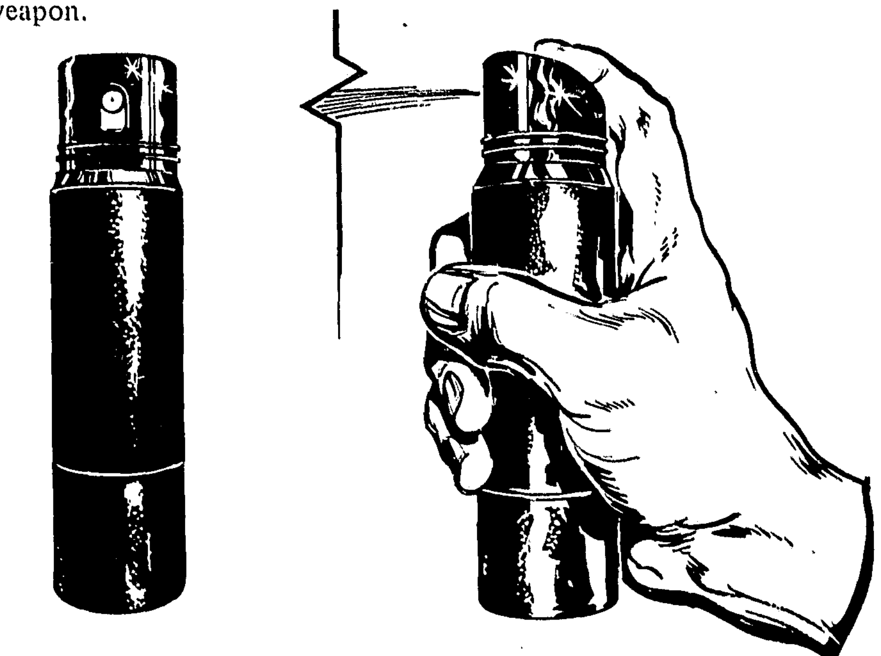


FIGURE 1 – THE STANDARD AEROSOL IRRITANT PROJECTOR
The typical unit is metal, black in color, cylindrical in shape, 6¼ inches in length and 1-3/8 inches in diameter, with a dispenser assembly in the top of the container. Gross weight is approximately 150 grams.

They should be used only in situations where a weapon is absolutely required to control violent behavior, and only as an alternative to more extreme applications of force. They should never under any circumstances be used indiscriminately or punitively. As a general rule, it would be safe to say that if a police officer is justified in using his nightstick, then he is justified in using an aerosol irritant projector. As a means of controlling a critical situation or effecting a forcible arrest, these nonlethal weapons have been used successfully thousands of times in the several years since their introduction. In spite of this success, however, there are three very important points which should be considered.

First, these projectors, if improperly used, can cause some degree of physical injury. They are, after all, weapons and do utilize irritants which in the best instance are unpleasant and which, by the very manner in which they function physiologically, do cause a greater or lesser degree of trauma. However, the possibility of some injury is implicit once the decision to use a weapon has been made, and in any event the risk involved in the use of the chemical device is likely to be much less than that resulting from the use of conventional weapons. The University of Michigan School of Medicine, in a report concerning one particular brand of aerosol irritant projector, states:

"The use of all anti-personnel weapons involves a calculated risk. The long history and the extensive use of chloroacetophenone (the principal active ingredient in most aerosol irritant projectors) as a temporary incapacitating agent in the control of riots throughout the world since World War I; the minimal injury reported in the world medical literature even under conditions which have undoubtedly involved indiscriminate use or misuse of this agent indicate the risk to be quite small, and in most instances negligible, in comparison with conventional weaponry."

Secondly, while the dynamics involved are not thoroughly understood, experience suggests that even the best of the aerosol irritant dispensers are not completely effective on some persons. While many reports of ineffectiveness can be traced to a failure to strike target personnel in the face with the irritant, there remains strong evidence that a person who is violently mentally ill or heavily under the influence of alcohol or narcotics *may* occasionally not react in a typical fashion to the chemical agent. Until such time as additional information on nontypical reactions is available, police officers should be aware of potential failure and trained to take appropriate additional defensive steps as necessary.

Finally, in addition to the hazard of over-use or misuse, there is also the possibility that the law enforcement agency may be sold an ineptly made and/or inadequately tested aerosol irritant projector. A number of firms, many of them small and with scant technical resources, have entered what appears to them to be a lucrative and growing new business. Responsible police administrators should gather as much information as they possibly can on a particular product, especially information and test results from unimpeachable and reputable outside testing agencies, before deciding what product to procure for department use. The fact that one aerosol irritant projector utilizes the same can and has the same outward physical appearance as another does not mean that data on one product can be used to establish the effectiveness and/or relative safety of another.

HOW THEY WORK

The aerosol irritant projector generally consists of a pressure tight canister with a self-closing valve and actuator (control button) spray nozzle combination, crimped to one end. About ½ to 3/4 of the available internal volume of this canister is occupied by the liquid irritant formulation. The remaining volume contains the propellent gas which supplies a pressure head to forcibly project the formulation from the nozzle when the valve is opened by depressing the actuator. A dip tube extends downward from the valve to just about the bottom of the canister. This insures expelling of the formulation rather than the propelling gas and explains why the projector should always be discharged in an upright position.

Although most available aerosol irritant projectors have the above elements in common, there are significant differences among them which are listed and discussed in order of importance.

1. The most important difference between all of the available aerosol irritant projectors is the background of tests and use data available for each brand. The department should not choose a weapon manufactured by a reliable company and copies of all available medical data, along with reports of effectiveness and safety from other departments relative to each brand under consideration, should be studied by the chief of police and the department's medical officer. All of the data evaluated in making a decision should be retained in the department's files to support a responsible selection should this ever become necessary. As a matter of policy, **police executives should not authorize the use of any chemical weapon for which the formulation and medical data are not available.**

2. Type, concentration, and purity of irritant:

   a. The most common irritant used in these devices in CN or alpha-chloroacetophenone. CN concentration of 0.9 percent has become almost an industry standard. This chemical can be used in two levels of purity, the technical grade or the recrystallized grade. The recrystallized grade is preferred as it reduces the possibility of formulation instability or possible injury due to extraneous impurities. CN concentrations beyond 1.5 or 2% are generally regarded as risky and should be avoided.

   b. Oleoresin capsicum or cayenne pepper is another irritant used in some formulations. This chemical is less effective than alpha-chloroacetophenone because it has a relatively low vapor pressure (that is, it does not vaporize readily), therefore, little or no eye irritation or lacrimation is caused unless the liquid actually reaches the surface of the eye or conjunctive; whereas the readily evolved vapors of CN-type formulations quickly reach the eye, even without liquid contact. Cayenne pepper projectors are not widely employed by U.S. Law enforcement agencies.

   c. CS or orthochlorobenzalmalononitrile has been seldom used in aerosol irritant projectors. Although this chemical when used in fogs, smokes and powders is more potent than CN, it has a much lower vapor pressure. Consequently, its effectiveness in aerosol irritant projectors is also limited by the need for a direct eye impact to achieve a rapid reaction. Another undesirable characteristic of CS for this application is that its effects are of unnecessarily long duration, since it tends to stay on the affected area rather than evaporate.

Recent work by Edgewood Arsenal on an aerosol irritant projector using CS in trioctylphosphate (TOF) has, however, disclosed desirable aspects. Duration of effects is reported to be about 20 minutes and prolonged contact with skin is said to produce a transient redness with no damage to the skin. Also, since the CS in TOF is not a volatile agent, vapor contamination of closed areas such as rooms or vehicles does not present a hazard to other law enforcement personnel in the area where the weapon is employed.

3. Type of solvent and/or carrier.

   The majority of currently available liquid irritant formulations, based upon CN or alpha-chloroacetophenone, use one or more halocarbon compounds as solvents and/or carriers. Some examples of solvents which have been detected in various devices are listed below:

   (1) trichlorotrifluoroethane
   (2) 1, 1, 1, -trichloroethane
   (3) methylene chloride
   (4) trichloroethylene
   (5) perchloroethylene
   (6) carbon tetrachloride
   (7) chloroform

Some of these compounds may, under certain circumstances, in the presence of oxygen, form phosgene or carbonyl chloride which is a class "A" poison and has been used as a war gas. It has been reported that the examination of some aerosol irritant projectors has disclosed a dangerous amount of phosgene which was probably the result of the use of compressed air to pressurize a formulation which utilized chloroform as a solvent.

4. Type of propellant.
   a. The preferred propellant to be used is carbon dioxide. Its stability, solubility characteristics, and capability of delivering low temperature performance, make it ideal for this application.
   b. Various Freon propellants, especially Freon 12, have been used. These propellants have created difficulty in some areas because their pressure falls off rapidly at subfreezing temperatures, making actuation of the weapon erratic or impossible.
   c. As noted above, compressed air is not preferred for pressurization of many formulations. An inert gas, such as nitrogen, or a stable gas, such as carbon dioxide and nitrous oxide, are far better choices.
5. Type of Cansiter.
   a. Almost all of these weapons use a seamless aluminum canister. It is recommended that one manufactured to meet the I. C. C. 2P specification be required. This specification insures an adequate burst pressure which is verified by a stringent testing procedure when the canister is manufactured. The 2P-type canister may be identified by a concave rather than a flat bottom.

WHAT THEY DO

The aerosol irritant projector is designed to discharge a chemical irritant into the face of a violent subject. The formulation is ideally released in a highly directional shot-gun type pattern of droplets. Any tendency to spray or mist reduces the accuracy, selectivity, and range of the projector, which under ideal conditions should be effective up to 15 or 20 feet.

While products vary, a typical projector might deliver 2.5 grams of formulation or approximately 25 milligrams of CN during a one-second burst. The standard canister should deliver approximately 40 such one-second bursts or an equivalent number of shorter releases. Although most of the CN is lost in the atmosphere during a release under normal conditions, the carrier/solvents impact on the skin with sufficient CN remaining to produce the desired effects.[1] Once deposited, the CN vaporizes and produces temporary reflex closure of the eyes, tearing, and a burning of the skin and upper respiratory tract. Some formulations are designed for immediate vaporization of the active agent while others prolong the effects by retarding vaporization with a relatively non-volatile carrier. Carriers also serve to reduce the natural protective oils of the body, thus increasing the effectiveness of the irritants in producing a burning or stinging sensation on impacted areas of the skin.

The active ingredient in CN projectors causes acute local tissue irritation to skin and eyes and this irritation is increased in severity in relation to the length of time that the active material remains in contact with the skin or eye tissue. For this reason, the preferred first aid treatment is flushing with cool water as soon as possible and contact should *not* be prolonged by the application of grease medications or salves which might seal the irritant against the skin and possibly cause chemical burns and blisters.

Temporary skin burns and conjunctivitis without lasting effects are possible, but even this risk is sharply minimized by the use of reliable formulations, the timely application of effective first aid procedures, and proper training of personnel in the use of the weapon. Improper use of irritant projectors, at a range of less than two feet and/or with no post-exposure first aid, has produced chemical burns of the cornea, persistent lesions of the eye, and second degree burns of the skin with blistering and peeling. However, even in these extreme cases of misuse, recovery has generally been complete with no residual effects. This is not to say that there is no risk of permanent injury from misuse of chemical weapons and police should anticipate that the use of unreliable formulations or the improper use of even the best formulations could produce permanent injury.

[1]CN induces tearing in man at a concentration of 0.3 mg/m^3.

OPERATIONAL GUIDELINES

Since aerosol irritant projectors are neither completely harmless nor universally effective, police agencies should provide operational guidelines covering when and how these non-lethal weapons are to be employed. Such policy must of course be integrated into the departmental training program at the recruit and in-service levels. For recruits, projector training should be included as an integral part of the defense tactics content of the basic curriculum. Roll-call training sessions provide an excellent format for insuring that in-service personnel are familiar with departmental policy and procedure governing the use of chemical weapons.

Projector training should include the firing of active or inert units under various conditions simulating police combat. It would not be unreasonable to require each trainee to expend the contents of a full dispenser in the training process. In addition, all personnel to be armed with irritant projectors should be exposed to the formulation if only through direct application of the chemical to the cheek with a cotton swab. Confidence in their ability to operate the weapon accurately and an appreciation of the effects of the formulation will encourage officers to make appropriate decisions regarding the use of irritant projectors.

During the fall of 1968, the City of Berkeley, California reviewed and sustained the use of an aerosol irritant projector, the Chemical Mace produced by the General Ordnance Equipment Company of Pittsburgh, Pennsylvania. In the course of this study, reports were submitted to the Mayor and Council by City Manager William C. Hanley and Public Health Director Alvin R. Leonard and revised guidelines were developed for police use of the projector. These guidelines, which are reproduced below with some modification, represent a cautious and reasonable policy.

1. Aerosol irritant projectors will only be used after all other reasonable efforts to control a violent person have failed. If you would not be justified in using your baton you are not justified in using the projector.
2. If the projector is used, the areas of the body exposed to the liquid must be flushed with water as quickly as possible. The required reports, explaining why the weapon was used, must also include information concerning the length of time between use and flushing with water.
3. After initial treatment, the subject will be inspected and interviewed not less than 30 minutes after exposure nor more than one hour from the time the irritant was used. If the subject is in jail this inspection will be made by the jailer; if not, it will be made by the officer who used the projector. If it appears warranted, the individual should be taken to the hospital emergency room for examination.
4. If the liquid has struck the clothing of the individual and he is to be incarcerated, he will be given an opportunity to shower and will be furnished jail clothing to replace his own.
5. Only under conditions which represent an extreme hazard (immediate threat of serious injury or death) to the officer will projectors be used under the following conditions. Regardless of the circumstances, these conditions require that the subject be taken to the hospital emergency room for such treatment as the doctor on duty feels necessary.
   a. Discharge of the weapon directly into the eye or face at very close range. (Less than two feet)
   b. Prolonged discharge at any effective distance into the face of an already incapacitated person or a person not responding to normal applications of the aerosol irritant formulations.
   c. Discharge of large quantities in a confined space such as a small room or closed automobile.
6. Projectors will not be discharged in the immediate vicinity of infants, since their respiratory systems are especially sensitive to irritating vapors.

The practice of requiring a written report on the use of chemical weapons is widespread and would appear to be a valid procedure even though it is generally resisted by operating personnel who have a natural tendency to resent any form of additional paper work. It is only through use reports that police executives and planners can evaluate the usefulness of irritant projectors and develop necessary procedural and training doctrine.

It should be possible, however, to design concise reporting formats that can be quickly completed in the field or during booking operations. Lengthy and elaborate forms required by some departments for the reporting of firearms discharge are not usually suitable for chemical weapons reports and only discourage compliance with reporting regulations.

One of the major manufacturers of irritant projectors, Federal Laboratories, Inc., of Saltsburg, Pennsylvania, provides a 3x5 inch card to be issued to persons who have been subjected to their Streamer projector. This card, which is illustrated below, could be adapted for use by any department and would be especially useful in those cases where no medical attention is provided and the subject is released from custody shortly after an arrrest involving the use of the irritant projector.

ATTENTION

You have been exposed to a device which contains a liquid chemical irritant which causes intense stinging of the skin and profuse tearing. Although highly irritating, the effects last only a short time, are not dangerous, and can be washed away.

The stinging and profuse tearing are caused by a chemical which is a harmless form of tear gas (a solution containing Chloroacetophenone).

To avoid possible skin irritation, the following steps should be taken:

1. Wash exposed area with soap and water to remove all oils and dirt which could entrap the irritant.
2. Flush the exposed area with a cool solution of baking soda or flush profusely with cold water 3-4 minutes.
3. Keep the washed areas exposed to fresh air allowing irritants to escape.

CAUTION: DO N O T APPLY OIL OR GREASE MEDICATIONS SUCH AS BUTTER, COLD CREAM, LANOLIN, VASELINE, LOTIONS, OR SALVES WHICH COULD FURTHER TRAP THE IRRITANT CAUSING SKIN BLISTERS. DO NOT BANDAGE EXPOSED AREAS, KEEP EXPOSED TO FRESH AIR.

FIGURE 2
FEDERAL LABORATORIES' "WASH-UP CARD"

SELECTING A PROJECTOR

In view of the fact that aerosol irritant projectors are currently being produced by perhaps twenty different firms, law enforcement officials are frequently faced with the task of selecting a unit in the face of conflicting and confusing claims and counterclaims. The decision process is further complicated by the willingness of less reputable suppliers to make false or misleading statements about their own or competitive products.

While most police officials are certainly in no position to evaluate complicated chemical formulations or engage in sophisticated medical research, they can and should develop minimum weapon specifications and require that suppliers meet certain requirements in providing product information and test results. The following minimal requirements should be considered for inclusion in specifications for the standard CN aerosol irritant projector. Needless to say, these standards should be certified in writing by the supplier and verbal assurances that a product is "the same" or "just as good as" another product should not be accepted.

Material and Workmanship

a. The material supplied under this specification shall be aerosol irritant projector hand weapons of such general nature that they will reliably fire a highly directional, shotgun-like pattern of heavy droplets when actuated according to manufacturers' instructions.

b. The material supplied shall give off no noxious or obnoxious vapors or odors under normal conditions of storage.

c. The manufacturer shall guarantee that each unit shall remain fully effective with no leakage or altering of the chemical stability of the material contained therein, for a period of at least four years from date of delivery. This guarantee shall apply to all units, full, partially used or stored.

Physical and Chemical Requirements

a. Each unit shall contain between .5 and 1.0 percent volume of a recrystallized (highly purified) grade of phenylchloromethylketone (CN).

b. The formulation should not be soluble or miscible in water or eye fluids nor contain any OH groups.

c. Each unit must contain a contact irritant material with the characteristic of immediate activation and evaporization upon contact with human skin, effecting instantaneous incapacitation.

d. The irritant material must be a non-toxic, wet substance, not a contaminating, gaseous material, which will cause discomfort to users or others not directly contacted with it.

e. The formulation must not be classified as an eye irritant within the parameters of the Federal Hazardous Substances Act as indicated by reports of an independent recognized testing laboratory.

f. The formulation must not be classified as a skin irritant within the parameters of the modified FHSA test as described in Appendix E and performed by an independent recognized testing laboratory.

g. The principal carrier/solvent used must carry an Underwriter's Laboratory toxicity rating of greater than 4.

h. Each unit will be capable of operating effectively and safely within a temperature range of from -30°F to +130°F.

i. The manufacturer must furnish written evidence that the supply canisters have been made to I. C. C. 2P specifications.

j. There shall be no oily residue crystallization build-up or leakage from either the nozzle, actuator sleeve, or exit ports after firing of the unit.

k. The formulation should be non-flammable.

l. The formulation should not contaminate the area nor leave an oily residue capable of staining clothing or equipment. Each unit should have an effective range of no less than 15 feet under calm wind conditions.

m. Each unit should have a repeat capability of no less than 40 one-second bursts with no less than 2 grams of formulation expended per burst.

n. Each unit should have a permanent serial number for control purposes.

o. Units shall be equipped with a safety collar on the trigger head or other safety device to prevent accidental discharge or firing.

Tests

a. The supplier shall submit an affidavit specifying the Underwriter's Laboratory toxicity rating of the principal carrier and the exact percentage of the active component. See Appendix E, Testing Aerosol Irritant Projector Formulations.

b. The supplier shall submit the report of an independent testing laboratory having conducted and recorded standard experiments on live animals to determine the eye and skin irritation and systemic toxicity of all components of the aerosol irritant projector to be supplied. See Appendix E, Testing Aerosol Irritant Projector Formulations.

NOW WHAT?

Although this discussion has dealt exclusively with the standard model irritant projectors, both smaller and larger units designed for specific applications are on the market and General Ordnance Equipment Corporation has released a second generation model designed to replace their current standard projector. All of these devices operate on the same general principles outlined for the standard model projector and are subject to the same operations restrictions and safeguards.

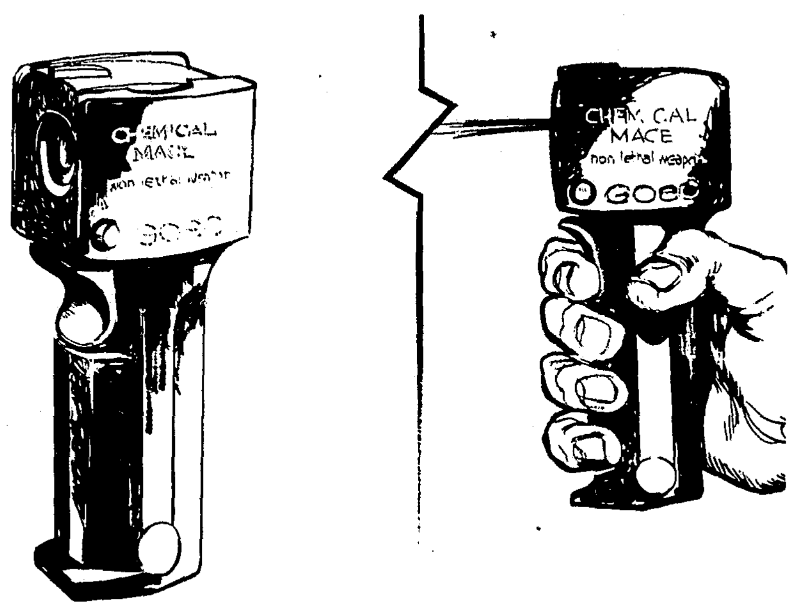


FIGURE 3
THE GOEC SECOND GENERATION PROJECTOR

Not even their most enthusiastic supporters would suggest that the current aerosol irritant projectors are a fully perfected answer to police requirements. However, the present weapons clearly represent an irreversible trend toward the development of a nonlethal arsenal that will some day provide law enforcement personnel with a full range of responses appropriate for any situation in which they may find themselves. Improvements in the design, formulation, and general performance of chemical weapons are inevitable and major innovations are already in the advanced stages of development. It only remains for law enforcement leaders to develop effective systems to evaluate and influence the output of an accelerating nonlethal weapons technology.

CHAPTER SIX

Protective Masks

The purpose of a protective mask is to afford the wearer respiratory and eye protection against undesirable chemicals in the atmosphere. Masks designed for use in areas contaminated by the chemical agents CN, DM and CS are generally of the canister type with a full face cover protecting the face and eyes.

The filtering capacity of the riot control agent protective mask canister is limited to the riot control agents CS, CN and DM. Protection from such toxic gases as carbon monoxide, smoke, ammonia and other lethal fumes requires chemical absorption and change which is beyond the capability of the canisters supplied with protective masks sold for use in riot control operations.

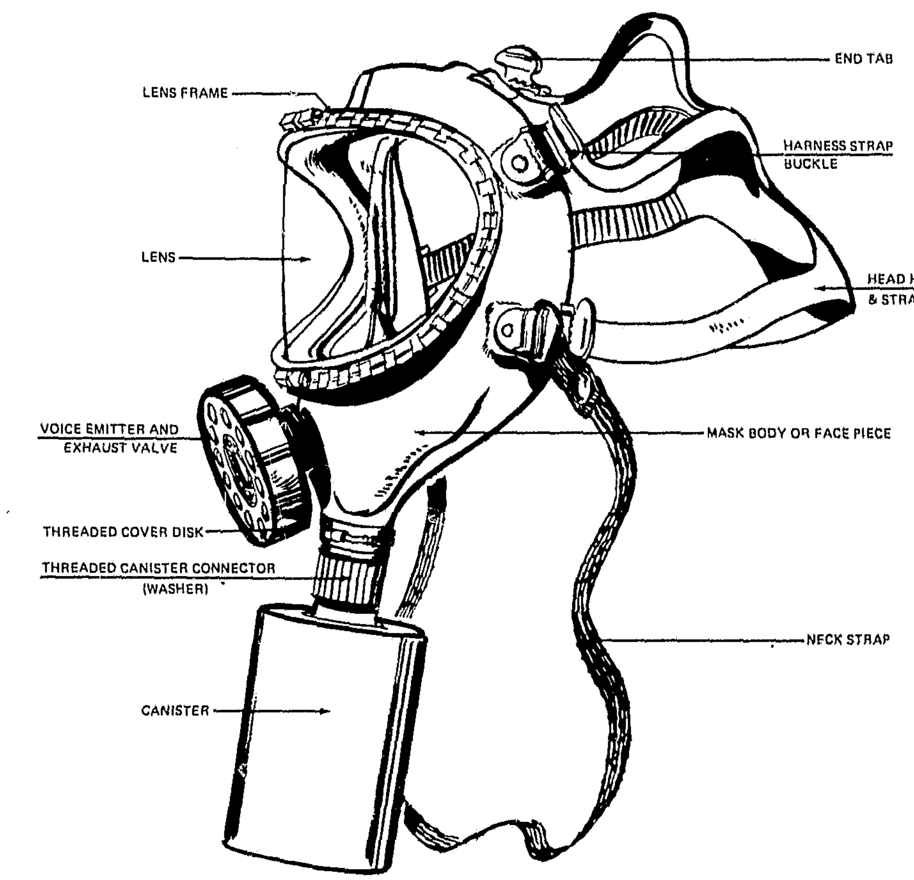


FIGURE 1 – RIOT CONTROL CHEMICAL AGENT PROTECTIVE MASK

The riot agent mask canister is a metal container with an intake opening in the bottom and a fitted outlet hole in the top. Various types of filtering materials are located within the canister to remove particles of agent from the inhaled air. A high efficiency fiber particulate pre-filter mechanically removes the particles of chemical agent as they enter the canister. The partially filtered air is then drawn into a second filter section composed of tightly packed activated charcoal granules which absorb the remaining irritant vapors and render the air ready for inhalation.

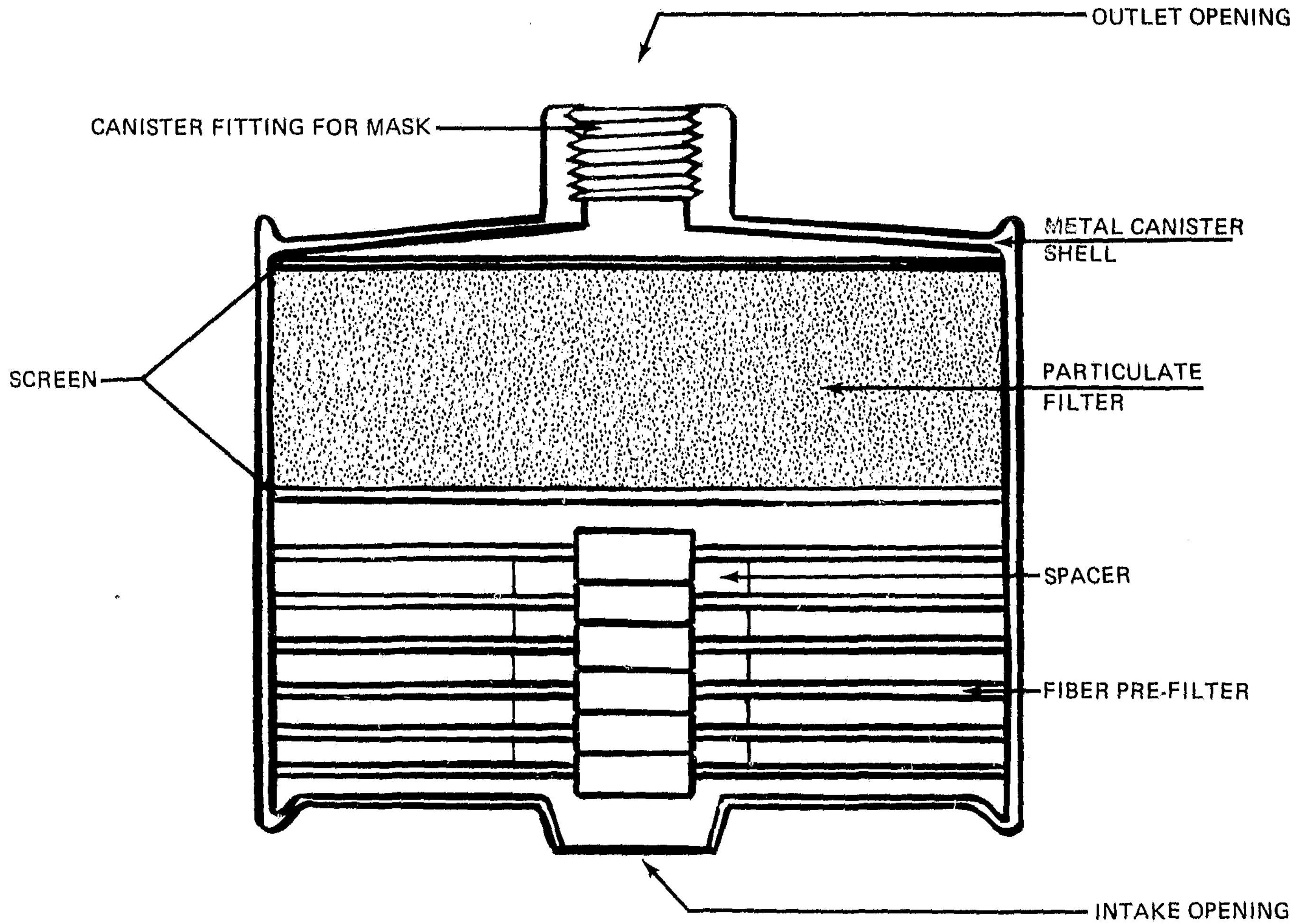


FIGURE 2 – RIOT CONTROL AGENT PROTECTIVE CANISTER

With the mask properly fitted to the face and head and the seal (tape) removed from the canister intake opening, the wearer should be protected from the eye and respiratory effects of riot agent irritant particles.

When the wearer inhales, his intake of breath creates a partial vacuum within the mask which is relieved by the inflow of air through the only non-resistive path, the canister and air intake channel. Contaminated air is drawn through the canister, filtered, and then flows up through the inlet channel of the face piece. The filtered air enters the face piece of the mask at the base of the eye lens where it also serves to reduce fogging before being inhaled during the breathing process.

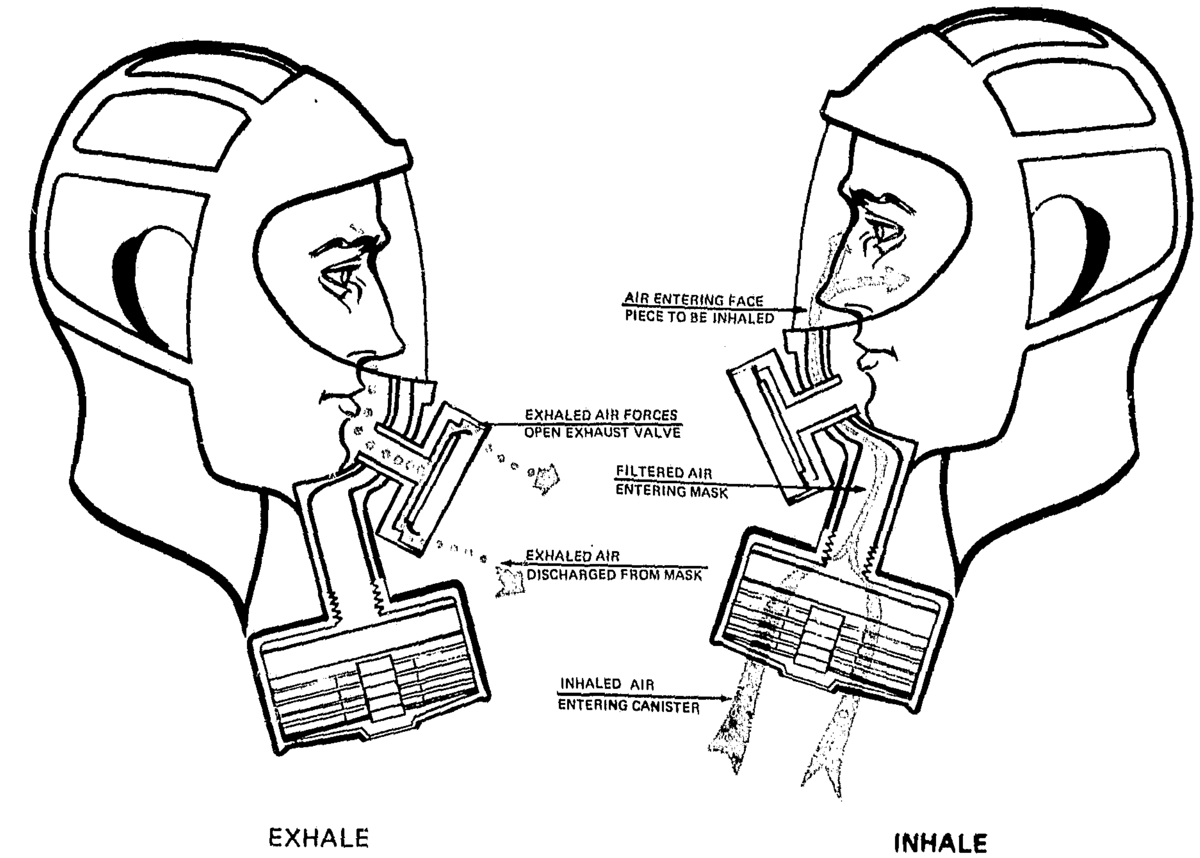


FIGURE 3 – AIR FLOW DIAGRAM

As the wearer exhales, pressure builds up within the mask. This pressure escapes through the least resistive outlet, which is an exhaust valve located at close proximity to the wearer's nose and mouth. The exhaust valve, which is molded from soft rubber, is pushed open by the exhaled air and then flaps shut when the pressure developed by exhaled air is removed. An inhalation check valve located either within the canister or on the mask prevents the exhaled air from re-entering the canister.

Some masks are equipped with voice transmitters, which are basically sound-powered audio projecting or strengthening devices. When functioning properly, they facilitate clear communications during operations when masks would otherwise reduce the volume and clarity of voice commands and the exchange of information.

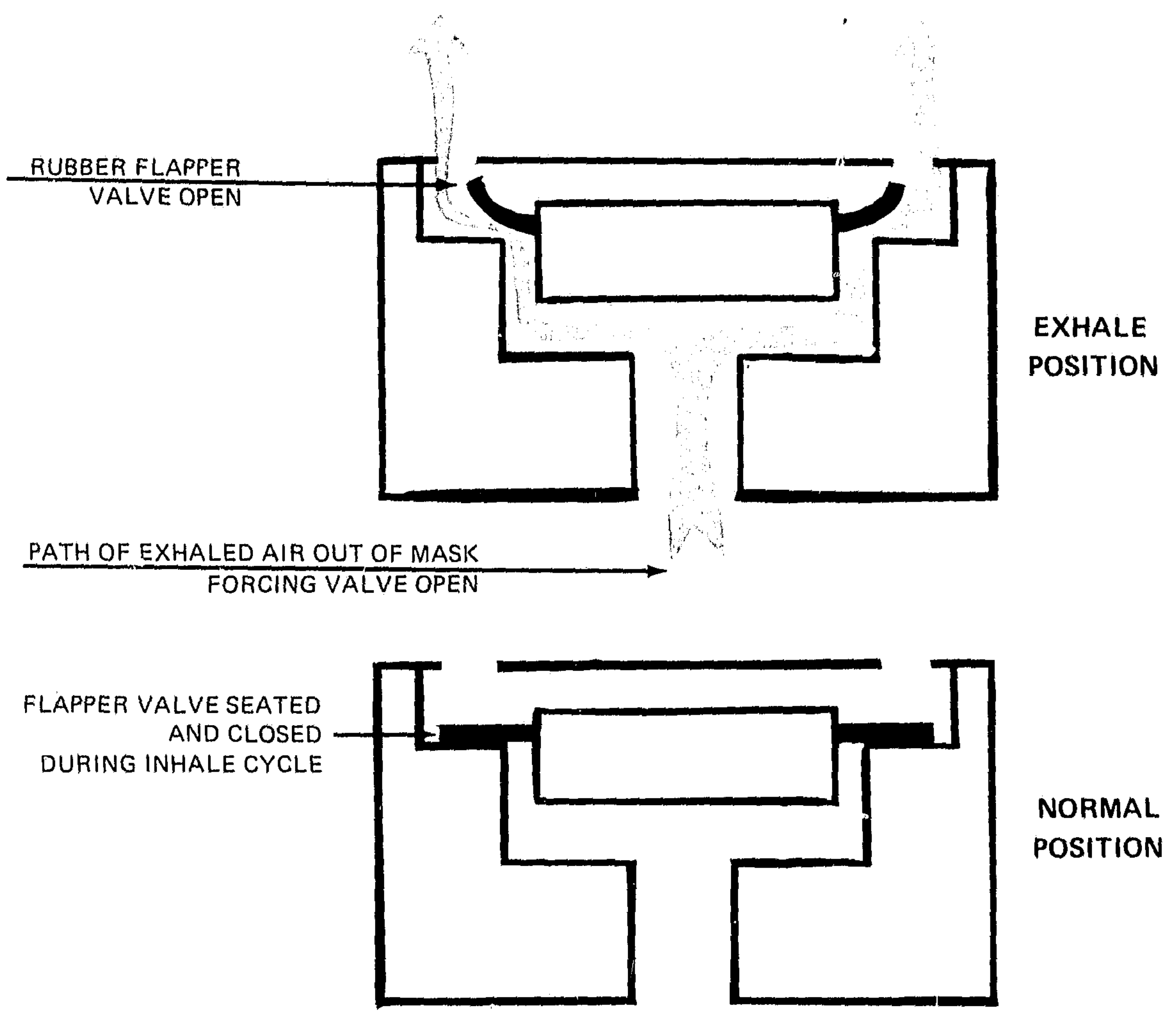


FIGURE 4 – OPERATION OF EXHAUST VALVE

MASK PRESTOCK LEVEL

Ideally, every member of a law enforcement agency should be issued a protective mask and held responsible for its care and maintenance. Unfortunately, the expense involved has precluded making the mask an item of individual equipment in all but a very few departments. In fact, an informal survey conducted by the IACP during the spring of 1968 indicated that the average department had only .28 masks per sworn officer.

While it is safe to assume that many cities have increased their mask stocks since the survey was completed, it is equally true that current supplies are considerably below minimum requirements. What constitutes a "minimum" mask prestock level may vary somewhat from department to department, but police planners should be guided by the assumption that a protective mask will be required by every officer assigned to a disorder area under any existing contingency plan.

Two factors have greatly increased the need for protective masking. First, the CS agent adopted by the military and used increasingly by civilian police demands greater protection due to its more incapacitating effects. Secondly, the "loss" of large amounts of riot control munitions in recent disorders suggests that the police may have lost their exclusive option on when and where chemical agents will be unleashed. Should militant groups in fact employ irritant chemicals against the police, the need for protective masks could well take on a grim new aspect.

For law enforcement officials caught up in the conflicting demands of a limited budget and practical necessity, there would appear to be several developments that may eventually resolve the protective mask dilemma. Public Law 90-351, the Omnibus Crime Control and Safe Streets Act of 1968, in Section 307(a), provides for special priority to programs and projects dealing with the control of riots and civil disorders and this provision may result in federal assistance that will supplement existing funds for the purchase of equipment, including protective masks.

Also of interest is the report that the military establishment has under development a riot agent mask that costs only five or six dollars a unit. Should this mask become available on the civilian market, it would substantially reduce the cost of adequate masking for law enforcement personnel.

Finally, and perhaps most promising for the immediate future, the Department of Defense has provided for the *loan* of protective masks to civilian authorities to meet "an urgent need during an actual disorder." The details of this program should be discussed with the commanding officer of the nearest military installation, with particular attention to the time factors involved. Although the IACP will furnish a summary of this loan program to law enforcement officials on a confidential basis, planning action must be initiated at the local level with the appropriate military commander.

EVALUATION OF PRESENT RIOT AGENT MASKS

Police departments for years have used chemical agents, particularly CN, as an effective means to draw out barricaded criminals and disband unruly groups of people. Over a period of time, a variety of different gas masks have been acquired by law enforcement agencies, including a number of military surplus masks possibly dating back to World War I. Many of the masks on hand may be unserviceable or ineffective, especially against the newer chemical agent CS.

To determine the serviceability and effectiveness of masks and canisters, three steps should be taken:

I. Inspect the face lens, straps, gaskets, valves and body of the mask for cracks, dry rot and unusual hardness of pliable parts. Should these defects be in areas which cannot be corrected with the addition of replacement parts, the mask should be discarded. Special attention should be given to the plastic face lens to determine that it is securely in place and sealed into the body of the mask. Face lenses which are scratched or discolored should be replaced to provide the wearer with maximum, undistorted vision.

II. The basic fit, airtight seal, comfort and visibility which the mask affords is of primary importance. An officer should be able to don his mask in a matter of seconds with a minimal amount of effort and wear the mask in relative comfort for sustained periods of time. Masks should be critically evaluated and repaired or discarded if difficult breathing, excessive fogging, unnecessary bulk, poor vision or an uncomfortable fit appear to create problems.

III. Check labels, if any, to determine canister limitations. The newer canisters should state that they will protect the wearer from the chemical agents CN, CS and DM. To provide this protection, a canister must filter out all irritating particles of the chemical agent. If the canister label does not state which types of chemical agents it filters out, this information should be requested from the manufacturer or determined by actual field testing.

Canisters which have gone beyond their expiration dates should be considered for replacement. If one year has elapsed since the canister seal was broken, the canister may have to be discarded and replaced regardless of the indicated expiration date. Whenever there is any question as to the reliability of canisters, they should be subjected to field levels of CS agent concentration. Canisters tested in this manner should be replaced under the following conditions:

(a) if contaminated air is detected by taste, odor, or irritation to eyes, nose or throat.

(b) if breathing becomes overly difficult and labored (inhalation breathing resistance indicates that the pre-filter may be clogged).

Masks and canisters which do not pass these minimal standards should be destroyed and replaced with new and tested equipment. The practice of retaining defective masks in storage only invites their accidental issue during the rush of emergency situations.

STORAGE AND MAINTENANCE

To insure the maximum longevity and continued effectiveness of protective masks, a program of specific maintenance and care must be initiated. Storage, cleaning and periodic inspections will insure that the department is prepared at all times to employ, or to defend against, chemical agents in accordance with emergency plans.

The responsibility for a continuing maintenance program must be assigned to a specific officer or unit and necessary inspections should be conducted by command personnel to insure compliance.

Storage

Maximum canister and mask life is dependent on proper storage conditions. A dry area with a moderate constant temperature will minimize deterioration to rubber parts of the mask and absorption of moisture by the canister. Excessive dampness and heat should be avoided.

Properly maintained masks with sealed canister attached should be kept in their carrying cases when not in use. Care should be taken to avoid folding or creasing the mask improperly when inserting it into its carrying case.

During storage, the protective tape which seals the bottom of the canisters should be firmly in place. The head straps on the body of the mask should be fully loosened, with end tabs pulled to the metal strap buckle to facilitate the rapid donning of the mask.

Maintenance

Protective masks should be cleaned and examined for serviceability after each use. The following procedure is recommended:

1. Remove the canister and loosen all straps.

2. Disassemble the voice transmitter accessory, outlet, and outlet valves.

3. Special care should be given to the eye pieces during cleaning to prevent abrasive damage to the plastic lens. After flushing with water, the lenses should be dried with a clean towel or tissue and examined for impaired visibility or faulty seal with the rubber face piece.

4. To decontaminate and clean, wash the rubber face piece with soap and warm water, avoiding the use of any abrasive cleaning compound on the plastic lenses. A soft bristle brush

CONTINUED

1 OF 3

may be used to remove grease or other foreign materials. To complete the washing process, the face piece should be thoroughly flushed with clear running water.

5. Next, to disinfect, the face piece should be immersed for two minutes in either a 50 part per million aqueous iodine solution or a hypochlorite solution of the same mixture. If neither of these solutions are available at a pharmacy or chemcial supply house, a 70% ethyl alcohol solution can be sponged onto the face piece. The ethyl alcohol solution can be purchased at most pharmacies.

6. After washing and disinfecting, hang the mask and allow it to air dry.

7. Examine the canister for physical damage and proper operation. If it is serviceable, it should be wiped clean with a damp cloth and the seal replaced. Never immerse the canister in water or allow any liquids to enter the canister opening during cleaning. Mark the canister with the date it was used and, when dry, replace it on the mask for storage.

8. Clean, dry and replace voice transmitter accessory, outlet, and outlet valves. Use extreme care to insure that the valves are installed and seated correctly. If worn or damaged, valves should always be replaced.

9. Inspect and clean carrying case as necessary and replace cleaned mask only after case is thoroughly dried.

FIELD OPERATIONS

Inspection – Regardless of departmental maintenance and storage procedures, each officer should immediately check the operating condition of the protective mask as soon as it is issued to him. The following steps are recommended:

1. The mask should be removed from its carrying case and checked for physical defects, i.e. broken or dry rotted head straps, cracked or severely scratched lenses, etc.

2. The tape should be removed from the bottom of the canister and the mask donned and adjusted. After the mask is securely in place, the wearer should take several breaths to test the canister's airflow. A slight resistance is normal, but any significant breathing resistance is an indication of a faulty canister which should be replaced.

3. The wearer should place his hand over the canister's intake opening, sealing the hole and then attempt to inhale. The vacuum within the face piece should draw the mask against the wearer's face preventing the intake of any air. If air enters, there are two possible malfunctions indicated. One, the mask may not be properly fitted onto the wearer's face. Or secondly, the exhaust valve may not be properly seated due to dirt, improper placement, or damage. A brief check of the valve can be made by removing the valve cover disk and removing any visible obstructions. If this does not alleviate the problem, the mask should be replaced.

Exhaust valves that do not close properly admit contaminated air, causing the wearer discomfort and often result in the premature replacement of the canister. For this reason the exhaust valve should always be examined before it is concluded that a canister is defective.

4. After the mask has been thoroughly checked, the tape should be replaced, sealing the canister intake. All head straps should be loosened to their maximum and the mask returned to its carrying case.

Carrying Position

Although most masks are furnished with carrying cases that can be adjusted for wear in any of several ways, the preferred position is around the wearer's waist. If worn around the neck, there is a possibility that the strap can be used by an attacker to choke the wearer. The protective mask carrying case should be positioned in such a manner that the mask can be easily and rapidly removed for use without obstructing access to the service revolver.

Masking

As a matter of tactical policy, personnel should put on their masks prior to the use of chemical agents or, whenever possible, outside of the contaminated area. The procedure for donning the mask is relatively simple and will be even further facilitated by prior training and adherence to the inspection practices outlined above.

1. Take the mask from its protective case and remove the tape seal on the canister intake. Affix the sealing tape to the side of the canister for future re-sealing.
2. Pull the head harness assembly over the head and let bottom straps fall down to back of neck. Insert chin into chin well of the face piece.
3. Tighten chin straps at bottom of face piece first, then temple straps and finally head straps(s). Adjust until the fit is comfortably tight.
4. To check mask fit, place palm of hand over the canister intake and inhale. Mask should collapse to the wearer's face and remain collapsed until the wearer exhales. Readjust face piece to correct for any leakage.

Breathing

The use of protective masks should be limited to those circumstances requiring the use of chemical agents or entry into a riot agent contamination area. It should be remembered that the filtering elements of the masks reduce breathing efficiency and create a resistance to normal breathing. Prolonged periods of strenuous activity while wearing the mask will hasten fatigue. Persons with a history of heart or lung disorders should be examined and cleared by a physician before being permitted to become involved in situations in which they *must* wear a protective mask, especially for extended periods or under conditions of heavy exertion.

Leakage

If the mask is in good condition and properly fitted it should provide adequate protection. Occasionally, however, the seal of the mask around the face area is broken by the bobbing of the canister produced by running. Whenever possible, the canister should be held with one hand during rapid movement to reduce vibration and avoid leakage.

In spite of all precautions, however, a mask may prove to be defective. In such cases a low grade contamination will enter the wearer's face piece. The symptoms of this type of contamination are a slight itching of the nose and minor eye discomfort. If the wearer feels that the discomfort seriously interferes with his mission, he should withdraw from the contaminated area and check his mask and canister. A substantial feeling of ill-being may be an indication that either the canister is defective or that there are other toxic chemicals present in the atmosphere. In either case, the wearer should withdraw from the concentration if discomfort or anxiety becomes severe.

A comprehensive program of recruit and in-service training in the operation and use of protective masks should be initiated for all departmental personnel and followed up by periodic refresher courses. Training programs must include actual experience in field concentrations of chemical agent, with trainees required to perform exertive tasks in order to fully appreciate the effects of fatigue and restricted breathing caused by the protective mask. In the final analysis, the chemical agent capability of any law enforcement agency can never exceed the ability of individual officers to rapidly and effectively employ protective masking equipment.

CHAPTER SEVEN

First Aid and Decontamination

Even the discriminate use of riot control agents is likely to create the need for first aid and decontamination measures. Fortunately, the procedures thus far developed for both first aid and decontamination are not complicated and should be easily understood and remembered by police personnel.

FIRST AID

The symptoms associated with CS and CN exposure are largely the result of irritation produced by extremely small, often submicron, particles that contact moist areas of the skin or are inhaled into the mouth, nose and lungs. The reaction of the psychophysical structure of an individual to either CS or CN, although relatively short in duration, is most uncomfortable. The severity of the symptoms is generally related to the concentration of the chemical agent, the duration of exposure, and to some extent the physiology of the victim.

While the effects of CS are more severe than those produced by CN, the same first aid procedures can be employed to gain relief from either agent. The initial step should always be to remove victims to an uncontaminated area and face them into the wind. While this is usually sufficient to produce relief quickly, additional first aid steps as outlined in Figure 1 can be applied as necessary. For severe or prolonged effects, difficulty in breathing, severe chest pain, or contamination of wounds, qualified medical aid should be obtained immediately.

In addition to the positive first aid steps recommended, there are certain things that should be avoided in the self-aid or first aid procedure.

AVOID	Rubbing the eyes or scratching irritated skin areas. This will only sustain the effects and cause more discomfort.
AVOID	Using small amounts of water on contaminated areas. When flushing away gross contamination use copious amounts of cool running water for at least ten minutes or one of the wash solutions recommended for CS in Figure 1.
AVOID	The use of any first aid creams, salves, vasoline or greases to cover irritated skin areas. These dressings may trap particles of chemical agent creating severe discomfort, chemical burns, and increased absorption into the skin.
AVOID	Touching contaminated clothing or equipment with bare hands. The agent is easily transfered to unprotected skin areas once the hands are contaminated.
AVOID	Continuing to wear wet clothing that has been contaminated by chemical agents. Severe chemical burns and blistering can result.

[illegible]

Area Affected	[illegible]	First Aid
	[illegible]	Remove affected person from the contaminated area to an open, up wind position. Remain calm, restrict activity. Major discomfort should disappear within 15 or 20 minutes.
Eyes	[illegible]	Keep eyes open facing wind. Do not rub eyes. Tearing helps clear the eyes. If particles of agent are lodged in eyes, wash out with copious amounts of cool water. Tears can be blotted away.
Skin	[illegible]	Sit and remain quiet to reduce sweating. Expose affected areas to the air. Gross contamination can be relieved by flushing with clear water for at least 10 minutes. For CS, a solution of 5 or 10% sodium bicarbonate ($NaHCO_3$) or sodium carbonate (Na_2CO_3) or a specially prepared skin wash solution (6.7% $NaHCO_3$, 3.3% Na_2CO_3 and 0.1% benzalkonium chloride in water) are superior to water and need be used only in small amounts.
Nose	[illegible]	Breathe normally. Blow nose to remove discharge. Nose drops should help if discomfort is severe.
Chest	[illegible]	The victim should relax and keep calm. Talking reassuringly to the victim will help to relieve his discomfort and prevent panic.

[illegible]

FIGURE 1 – FIRST AID CHART

During chemical operations police should be especially alert for persons who are evidencing unusual behavior or who appear to be totally incapacitated by the agent concentration. Personnel responding to the agent in these ways should be removed at once to an uncontaminated area and medical assistance obtained. Since the possibility of serious injury or death is always much greater when chemical agents are used in enclosed areas, first aid and rescue procedures are even more essential during operations of this kind.

To relieve front line riot control personnel from the task of casualty management, police planners may wish to consider the designation of clearly identified first aid teams to follow up tactical personnel under civil disorder conditions. Whether made up of policemen, medical personnel, or qualified volunteers, these teams can not only assist severely affected chemical agent victims, but can also administer first aid to police personnel and prevent their loss from the scene of action for treatment of minor injuries.

DECONTAMINATION

Both CN and CS can cause contamination difficulties, although the lower volitility of the latter agent results in a much more severe decontamination problem. Most decontamination is required in buildings or vehicles since outdoor air and weather conditions are usually sufficient to make exterior decontamination unnecessary under normal civil disorder control conditions.

CS Decontamination Complete decontamination of CS agent has proved to be extremely difficult. Major industrial and research corporations are presently attempting to develop techniques that will provide more satisfactory decontamination and there is indication that improved agent dissemination methods may reduce the severity of the contamination problem.

In the meantime, the techniques recommended below have proven useful in reducing CS contamination, especially on surfaces that are hard and non-absorbent. Commercial stocks of clothing, food items, furnishings, other non-washable goods and electronic equipment do not lend themselves to this type of treatment and may have to be discarded or, since they require cleaning, sold as second hand merchandise.

The decontamination of buildings and items of equipment can be attempted by following the four steps outlined below:

1. AERATION

The first step in the decontamination process is to remove all airborne particles of the chemical agent within the building. Doors and windows should be opened to create a draft. Smoke ejector type fans should be used to "exhaust" the air from the building. This is usually best accomplished by arranging the exhaust fans to provide a constant flow of air in a single direction through the building. These fans should remain in operation until the total decontamination process is completed.

2. VACUUMING

The contaminated area should be vacuumed in its entirety, using a commercial water vacuum cleaner. Should this closed type of vacuum cleaner be unavailable, a regular vacuum cleaner may be used after wetting the dust bag to provide a more effective filter. A dry bag will not filter out the chemical agent, which will be exhausted from the vacuum cleaner and recontaminate the area.

3. REMOVAL

Cloth covered furniture, disposable goods, and other items which cannot be decontaminated should be removed. These items can either be destroyed or exposed to the air, breeze and sunlight which may reduce their contamination. The local health service agency should be consulted by merchants regarding the sale of goods that have been contaminated by riot control agents.

4. CHEMICAL DECONTAMINANT

Commercial or improvised solutions can aid in decontamination. The liquid is applied with a broom, brush, or mop, to contaminated surfaces, where it is allowed to remain for about ten minutes before being rinsed away with tap water.

Research has indicated that a reasonably effective chemical decontaminant can be improvised by preparing a solution of water containing 10% MEA (Monoeth anolamine) and 0.3% Triton X-100 or Igepal CO-630. The Triton X-100 (or Igepal CO-630) dissolves the CS and the MEA changes it chemically to produce harmless byproducts.

The chemicals required for the decontamination solution can usually be obtained from the chemical supply houses listed in the yellow pages of most telephone directories. If the Triton X-100 or Igepal CO-630 is not available, the commercial detergents known as Tide or Joy can be substituted. There is no substitute for MEA, but when it is not available the recommended solution, minus the MEA, can still be used to dissolve the CS. The solution must then be removed physically by sweeping, mopping, or flushing with generous amounts of water.

The easiest way to prepare the decontamination solution is to mix 6 2/3 pints (1 part) of MEA with about 55 pints (10 parts) of distilled water and then stir in about 3 ounces (1/2 part) of Triton X-100 (or Igepal CO-630). If distilled water is not available use tap water and twice as much Triton X-100.

This improvised decontaminant will dissolve and decontaminate CS in about two minutes after which it should be flushed away with water. Personnel working with the decontaminant should wear rubber gloves, boots, and finely woven clothing to prevent irritation of exposed skin by the CS before it is neutralized by the decontaminant. A protective mask may be necessary where contamination is heavy or the agent is kept airborne by exhaust fans.

Contamination of personal clothing by field levels of CS agent can usually be neutralized by normal laundry or dry cleaning. Where contamination is heavy, clothing should be aired thoroughly prior to cleaning. Personnel exposed to normal concentrations should change clothing as soon as practical and shower in large amounts of cool water. Once the skin and hair are completely rinsed, the body can be washed with soap and warm water in the usual manner.

CN Decontamination. Because CN agent vaporizes at a much faster rate than CS, aeration and vacuuming alone are often sufficient to achieve decontamination. In more difficult cases a decontaminant of strong soda ash solution or alcoholic caustic soda can be applied. In severe cases, or where the nature of the agent is unknown, the CS decontamination process can be followed since this procedure will also work for CN. Also, the following procedure is recommended by Federal Laboratories for treatment of severe CN contamination:

1. Open all windows and doors that weather permits. The sooner this can be done, the better. Up to an hour's airing is helpful; beyond this time little is gained.

2. Shut all doors and windows except one at each end of the building. Place a fan blowing to the outside at one of the openings. Heat the building as hot as is practical. This treatment vaporizes the agent and carries it out of the building.

3. Vacuum floors, draperies, rugs, bedding, and overstuffed furniture. This is especially important if CN dust was used, but it is also helpful if CN tear smoke caused the contamination.

4. Surfaces which will not be harmed by the treatment can be decontaminated with a 5% solution of washing soda (sodium carbonate). This chemical decomposes the CN. Baking soda (sodium bicarbonate) will also work, but more slowly.

CHAPTER EIGHT

Chemical Agent Training

Because of the infrequency of chemical operations, chemical agent instruction normally must accept a relatively low priority on the crowded police training calendar. It is precisely for this reason, however, that such training must be carefully planned and executed to obtain the maximum benefit from the limited learning opportunity that can be provided.

In discussing the development of chemical agent training, this chapter makes two basic assumptions. First, it is presumed that the police agency has developed a chemical agent policy and that this direction has been translated into operating procedures. If this is not the case, policy formulation should be accomplished before planning is undertaken for the development of training programs.[1] Secondly, it is accepted that chemical agent training must be tailored to fit within available training resources, which is simply to recognize the fact that there are sharp limitations on the time and energy that can be allocated to chemical agents instruction in the average police department. By following the guidelines suggested in this chapter, which are equally applicable to any kind of training development, it should be possible to establish effective chemical agent training programs within the ever present limitations imposed by the availability of time and money.

DEFINING TRAINING OBJECTIVES

The first step in the planning of any training program is to decide *who* is to be trained *to do what*. Operational personnel, supervisors, technicians and command personnel may all be identified as separate target groups for chemical agent training, depending upon what role they are assigned by established procedure and emergency plans. Since it is best to define training objectives in terms of behavior, rather than knowledge, the simplest approach is to study organizational chemical agent procedures and plans to determine what the target group will be expected to do. For example, performance goals for the patrolman or deputy in operations against crowds might be stated in a training outline as indicated below:

"BEHAVIORAL" TRAINING GOALS OUTLINE

A. Under supervision, correctly:

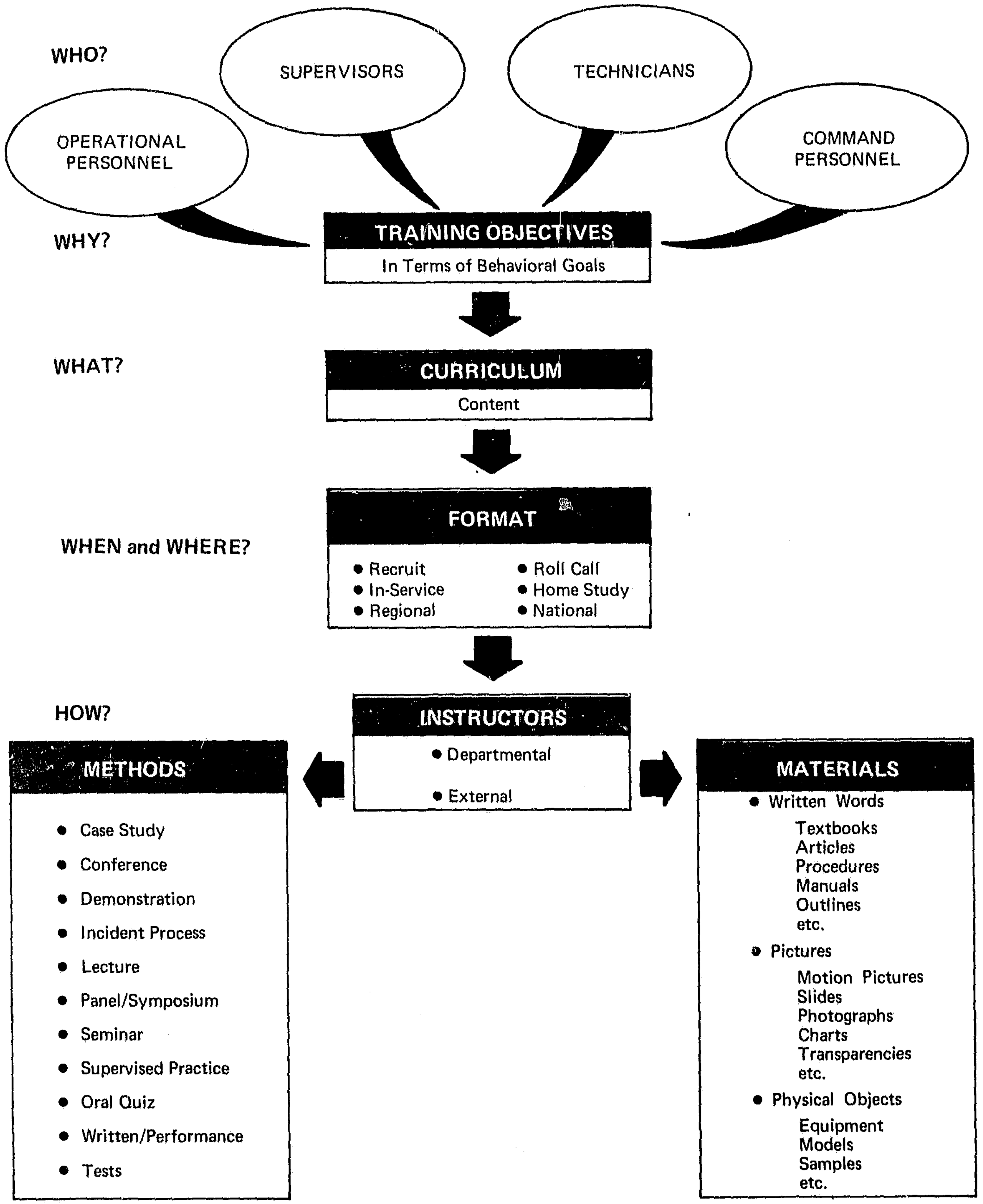
1. Handle, activate, and discharge the (brand) burning and (brand) expulsion grenades.

2. Carry, load, aim, fire and clear the (brand) 1.5 caliber riot gas gun employing the (brand) unstabilized and (brand) stabilized projectiles. Three out of 5 unstabilized projectiles must impact in a 20 foot circle at _____ yards. Three out of five stabilized projectiles must penetrate a vertical window-size target at _____ yards.

3. Employ CN and CS chemical agent grenades and projectiles in such a manner as to minimize risk of serious injury to friendly or target personnel.

[1] See Chapter One, Chemical Agent Policy and Procedure.

FIGURE 1 – TRAINING DEVELOPMENT SEQUENCE



B. Without direct supervision, correctly:

1. Carry, pre-test, and perform field maintenance on the protective mask. Put on, clear, and activate the mask within a period of 15 seconds in an agent concentration.

2. Draw, load, aim and fire the service revolver while wearing the protective mask, achieving a score of_____ on the silhouette target at _____ yards.

3. Load, aim, and fire the 12 gauge riot shotgun while wearing the protective mask, achieving a score of_____ on the _____ range at _____ yards.

4. Administer CN and CS first aid, self-aid, and decontamination.

While this inventory of behavioral objectives may not be complete, it serves to illustrate two desirable characteristics of this approach. First, performance objectives sharply define the desired outcome and focus upon exactly what must be learned. For example, A1 tells what the officer needs to know about grenades; not *all* grenades, just those that he will use. Not *all* about the grenades he will use, just how they are safely and correctly handled, activated, and discharged. The second major advantage of stating training objectives in terms of behavioral outcome is that it almost always provides a reliable, built-in measure of achievement. Since in the final analysis the trainer is more interested in performance than in knowledge, behavior provides a far better criteria than information for the evaluation of any training program.

The value of behavioral or performance oriented training objectives becomes even more apparent when the learning objectives listed in the Behavior Outline are translated back into more traditional terms:

"KNOWLEDGE" TRAINING GOALS OUTLINE

The officer must know about (or be familiar with)

A. Chemical agent grenades

B. The operation of the riot gas gun

C. Chemical agents and their use

D. The protective mask

E. Use of firearms while masked

F. Chemical agent first aid and decontamination

Clearly, the same topics are covered in both the "behavioral" approach and the "knowledge" approach. The difference lies in the preciseness that the former brings to the instructional planning and evaluation process.

CURRICULUM AND FORMAT

Once behavioral training objectives have been identified, the development of curriculum follows naturally. When present knowledge and skills are subtracted from the needed knowledge and skills, the remainder is what must be taught in the training program. There is always a strong tendency in curriculum development to proceed from the point of view of "covering the subject" rather than attempting to identify essential elements. This results in considerable "fat" in the training program and, while this is not inherently bad, it is easy to foresee the result if this tendency prevails in each of the dozens of topic areas that make up a total training program.

When the "Who", "Why", and "What" of the training development sequence have been decided, the next step is to determine when and where the instruction will take place. Within the department, recruit, in-service, roll-call and even home study training can be employed as a vehicle for the curriculum, depending upon the personnel to be trained and the nature and duration of the necessary instruction. Externally, regional and national training programs can be used to supplement departmental chemical agent training, especially for command and technical personnel.

Effective learning requires reinforcement and this is particularly true of skills that are infrequently used. Even with adequate recruit and in-service training programs it is still necessary to refresh chemical agent instruction through periodic roll-call supplements and training bulletins. Again, an attempt should be made to isolate key concepts and focus upon those performance deficiencies that have been identified by a continuing evaluation of police chemical operations in the field.

While curriculum should be developed to meet the specific requirements of each law enforcement agency, Figure 2 is included as an example of what the chemical agent segment of a recruit training program might contain. The curriculum should not include detailed material on agents, weapons, or tactics that are not a part of the department's riot control planning or which will not be employed by operational personnel. The classroom time required in the recruit schedule for a curriculum such as the one illustrated in Figure 2 will depend upon the usual variables, but a period of about three hours would be a reasonable estimate. The field or range time will vary from one to several hours, depending on whether the trainees will be qualified in the use of chemical weapons or simply exposed to a demonstration of such devices. While there is no question that personnel *should* be qualified, the time and cost involved may be prohibitive for some departments.

FIGURE 2 – BASIC OR RECRUIT CHEMICAL AGENT CURRICULUM OUTLINE

I. INTRODUCTION TO CHEMICAL AGENTS

A. [illegible]
   1. [illegible] ([illegible] and [illegible])
   2. [illegible]
   3. [illegible]

B. [illegible]
   1. Types and Characteristics
      a. [illegible]C ([illegible])
      b. CN ([illegible])
      c. CS ([illegible])
   2. Dissemination methods and characteristics
      a. Pyrotechnic ([illegible])
      b. Expulsion ([illegible])
      c. Liquid
      d. Fog

C. First Aid, Self-Defense and Decontamination

D. Protective Masks
   1. Purpose and limitations
   2. Description
   3. Field use
   4. Employing firearms while masked
   5. Maintenance

II. CHEMICAL WEAPONS

A. Grenades/Chemical Wand

B. Riot Gas Gun
   1. Stabilized projectiles
   2. Unstabilized projectiles
   3. Expulsion cartridges

C. Bulk Dispensers

D. Aerosol Irritant Projectors
   1. Operation
   2. Characteristics
   3. Guidelines for use
   4. Reporting requirements

III. CHEMICAL AGENT TACTICS

A. Agent Behavior

B. Objectives
   1. Large crowds
   2. Smaller groups
   3. Snipers/barricaded criminals
   4. Self-defense

IV. FIELD/RANGE DEMONSTRATION OR QUALIFICATION

The development of curriculum for other groups will follow the same principles outlined for operational personnel. For example, in the case of supervisory personnel it can be assumed that they need to be familiar with the skills and knowledge required by their subordinates as reflected in the basic curriculum in Figure 2. In addition, however, they will also require a separate or supplementary curriculum that would support a set of somewhat different behavioral objectives. Figure 3 suggests some of the special topics that might be included in a chemical agents training program for supervisory personnel.

FIGURE 3 – TYPICAL SUPERVISORY CHEMICAL AGENTS TRAINING TOPICS

- Legal and policy foundations underlying the police use of chemical agents
- Chemical agent risk evaluation (safety)
- Tactical decision making
- Estimating chemical munitions requirements
- Control of chemical agent operations
- Employment of bulk agent dispensers
- Selection of subordinates for chemical agent operations
- Chemical munitions field resupply
- Disposal of defective chemical munitions
- After-action reporting

PLANNING INSTRUCTION

The final step in the training development sequence is the identification of one or more instructors who, in turn, usually are free to select the specific instructional methods and materials that will be employed. While instruction has been presented over the years by chemical munitions factory representatives and salesmen, police agencies should make every attempt to provide their own instructors. When outside instructors are used, the department loses control over content and consequently may fail to meet predetermined training objectives. Ideally, any department of sufficient size to conduct a recruit training program would have appointed a chemical agent officer who could handle instruction in the area of his specialization. When absolutely necessary to obtain an instructor from outside the department, it is best to turn to another law enforcement organization for qualified assistance.

No less than 13 basic training methods (Figure 4) have been identified and at least 10 of these techniques would appear to be appropriate for various levels of chemical agent training. The selection of the method or methods to be used will depend upon the instructor, the curriculum, the format and the student group.

FIGURE 4 – BASIC TRAINING METHODS

√ 1. Case Study	√ 6. Incident Process	√ 11. Seminar
√ 2. Conference	√ 7. Lecture	√ 12. Supervised Practice
3. Debate	√ 8. Oral Quiz	√ 13. Written/Performance Tests
√ 4. Demonstration	√ 9. Panel/Symposium	
5. Forum	10. Recordings	

With the exception of the oral quiz and the written or performance tests, which are self explanatory, the various training methods are defined and evaluated briefly in Figure 5. Although past chemical agent instruction, like most police training, has used primarily the lecture and demonstration method, other techniques can and should be employed, especially when working with command, supervisory, and technical personnel who often bring considerable knowledge and experience into the training situation.

Printed material, pictures, and physical objects (Figure 6) can be used to enhance chemical agent training at all levels. While some documents, such as departmental procedures and manufacturers literature, can be included in the training program without change, it will usually be necessary to develop specific written materials to support desired training objectives. A selected bibliography of chemical agent publications is included in this manual as Appendix D, but, at least for training at the basic and supervisory levels, this listing will be useful mainly as a source of background material for instructors and those planning training programs.

Motion pictures, slides, charts, diagrams, overhead transparencies and opaque projections can be used effectively to illustrate instruction and increase learning. Unfortunately, there are few motion pictures presently available (Figure 7) for chemical agent instruction and those in use are generally outdated or incomplete. Slides and transparencies can be prepared locally at a reasonable cost and many of the illustrations in this manual have been reproduced larger than necessary to permit their use in the production of visual training aids. The Lake Erie Chemical Division of Smith and Wesson has prepared a series of large charts illustrating their grenades and these or locally prepared charts are especially valuable in helping students understand munitions design and functioning. The illustrations in Appendix C can be placed on overhead transparencies to serve the same purpose.

Physical objects, like equipment and cut-away models of munitions, should be included to support instruction wherever appropriate. They will generate interest, add realism to classroom sessions, and make difficult procedures easier to understand. The maximum value of physical objects is achieved when they can actually be handled and examined by students. When simply held by the instructor, objects lose most of their impact and for this reason it is often desirable to have on hand enough of the same objects to permit the entire group to examine them at the time they are being discussed.

FIELD TRAINING

A shortage of time and money remains the greatest deterrent to adequate chemical agent field training. Ideally, each officer should be qualified in the use of any chemical weapon that he might be called upon to employ and should demonstrate an ability to operate in chemical agent concentrations, including the use of standard firearms. Even if out-dated munitions are used, the cost of field training is substantial.

Federal Laboratories has developed a line of practice munitions that can be reused to reduce training cost. Grenades that do not explode or rupture can be recovered, decontaminated, loaded with sand to approximate weight, and reused in training. For aerosol irritant projector instruction, most manufacturers will provide free or low cost training weapons that function exactly like the service unit but contain no active chemical agent. Inert loading for bulk dispenser training will also help to cut training costs. With a little effort and ingenuity it is possible to avoid at least some of the expense associated with chemical agent field training.

The keynote of effective field training is realism. For example, instead of having the students simply mask up and stand in a circle while a grenade is discharged, they should run for about 150 yards, don their protective masks, jog for another 50 yards into an agent concentration and then carry out a simulated tactical operation against a barricaded criminal or a large crowd. In this way the trainee will learn to perform under the kind of difficult conditions encountered in actual field operations.

A range or course for qualification on chemical weapons can be constructed in any isolated area with scrap materials and imagination. Targets for grenades and unstabilized projectiles can be circles on the ground and a door or window frame will provide a good target for stabilized projectiles. The minimum standards of performance required to qualify with chemical weapons should be established in response to local needs and training capabilities.

FIGURE 5

POSSIBLE CHEMICAL AGENT TRAINING METHODS *

METHOD	DESCRIPTION	MAJOR ADVANTAGES	MAJOR DISADVANTAGES	LEVEL
[redacted]	Group discussion of an actual or hypothetical case history. The session is directed by a discussion leader. As a result of normal record and reporting systems, police agencies are in a good position to assemble case history summaries.	• All members of the training group can participate. • Develops problem-solving ability. • Independent thinking is encouraged. • Analytical skills developed. • Stimulates cooperation within the group. • Training seen as dealing with "real" problems.	• Requires a small training group. • Leader must be skillful and must also know subject matter. • Time involvement is great and generally unpredictable in advance. • Complicated cases will require advance study by the group.	Command Supervisory
	Group discussion of a subject with which members have previous knowledge or experience. Discussion leader, who may be chosen by the group, provides rather firm control by introducing the subject, starting discussion, keeping discussion on the subject, and summarizing at the conclusion of the session.	• All members of the training group can participate. • Stimulates cooperation within the group. • Pools ideas, information, and knowledge from many sources. • Especially useful for – Exploring problems to which answers are unknown. – Developing a new philosophy or approach. – Developing different aspects of a problem.	• All members must have prior knowledge or experience. • Practical only with small groups. • Not efficient for new subject matter. • Requires more time to cover the subject. • Can get off the subject unless skillfully led. • Can be difficult with personnel with conflicting personalities or opinions.	Command Supervisory

METHOD	DESCRIPTION	MAJOR ADVANTAGES	MAJOR DISADVANTAGES	LEVEL
[redacted]	Instructor or an assistant executes a procedure so that the group can see exactly how something is done. For maximum learning value the demonstration should be followed by student performance whenever possible.	• Usually holds student interest. • Aids motivation. • Helps to emphasize or clarify important or difficult points. • Illustrates application of theory or principle. • Emphasizes correct procedure.	• May require careful preparation and rehearsal if the task is complex. • All members of a large group may not be able to see well. • Trainees may miss point unless the purpose of the demonstration and important points are made clear. • Some subject matter does not lend itself to demonstration. • May be expensive in the case of chemical munitions.	Basic Supervisory Technical
	Same as *Case Study*, except discussion starts with an incident. Group has to develop, by questioning the discussion leader, the facts that they would be given in the case study. Group also has to define the real issue and decide on some recommended course of action.	• Same as for case study, plus – Requires no advance study by the group. – Develops skills in obtaining facts by questioning. – Pressure to decide on action can develop an ability to reconcile differences.	• Requires small group. • Requires skillful leadership. • Takes time. • Forced decision-making may create resentment.	Command Supervisory

METHOD	DESCRIPTION	MAJOR ADVANTAGES	MAJOR DISADVANTAGES	LEVEL
5. Lecture	One instructor speaks to the group. Although questions and answers may be permitted, the tone of the session is somewhat formal.	• Familiar, flexible, and easy to arrange. • An organized, systematic way of presenting material. • Can reach a large number of people in a short time. • Assures uniformity of information-giving. • Especially useful for – Giving new facts or information. – Stimulating interest. – Supplementing or stressing reading assignments. – Summarizing the results of other instructional method sessions.	• Dynamic speakers may be difficult to find in the subject area. • Speaker cannot always judge accurately group members' understanding. • Can be tiring to group, especially if long. • Limited group participation. • Not very suitable for controversial subjects or teaching human relations skills.	Basic Technical Some Supervisory
6. Panel/Symposium	Presentation by a small group of speakers followed by questions from the audience. Usually used when outside experts are available for only a limited amount of time.	• Can reach large number of people in short time. • Fast pace and change in speakers holds interest. • Brings knowledge from a variety of sources to bear on the subject. • Spotlights issues. • Brings out opposing views.	• Requires advance preparation and coordination. • Limited in general to views of the speakers. • Can easily get off the intended subject. • Provides for only limited group participation. • Not effective for presenting detailed or technical information.	Command Supervisory

METHOD	DESCRIPTION	MAJOR ADVANTAGES	MAJOR DISADVANTAGES	LEVEL
7. Seminar	Group discussion or exploration by highly experienced people working under minimal formal leadership. Subject matter for which ready answers are not available.	• Same as for conference. • Especially useful for situations in which there is no predetermined solution.	• Requires even more subject-matter knowledge on part of members than does the conference. • Practical only with small groups. • Not appropriate for presenting known subject matter. • Can get off the subject. • Some participants may dominate in the absence of formal discussion leader.	Command
8. Supervised Practice	Students perform procedure or task under direct supervision of instructor.	• Increases interest and enthusiasm. • Gives vivid, first-hand experience. • Emphasizes correct procedure. • Provides opportunity to evaluate training outcome in terms of actual behavior.	• Requires highly qualified instructors. • Instructor can handle only very small group. • May be expensive in the case of chemical munitions.	Basic Technical

*Adapted from Dinkin, Raymond, *Teaching Methods and Techniques*, U. S. Government Printing Office, 1962.

FIGURE 6

CHEMICAL AGENT TRAINING MATERIALS

MATERIALS	DESCRIPTION	MAJOR ADVANTAGES	MAJOR DISADVANTAGES
	Textbooks, articles, outlines, summaries, procedures, policy documents, manuals, etc.	• Can reach large numbers of people with the same information. • Can be studied at times and conditions suitable to trainee. • Usually represent superior expression of ideas and information. • Reading is an efficient way of learning; knowledge so acquired probably represents most of the total knowledge of the average police officer.	• Some people do not like to read except for entertainment. • Some people do not seen to learn well by reading. • It is difficult and time-consuming work to find and select good reading materials. • Training materials often have to be specially developed to be suitable for the purpose intended.
	Motion pictures, photographs, slides, charts, diagrams, overhead transparencies, opaque projections, etc.	• Add interest • Facilitate understanding • Focus attention, help trainees to remember. • Reveal hidden or difficult to see objects or processes. • Provide variety, change of pace.	• Instructors tend to rely on them too heavily. • Can seldom do the whole training job – should be used as aids or supplements • Sometimes difficult to integrate properly with other teaching methods and aids. • Suitable pictures not always available and may be difficult or expensive to produce. • Some require a darkened room which inhibits student/instructor contact.

MATERIALS	DESCRIPTION	MAJOR ADVANTAGES	MAJOR DISADVANTAGES
	Equipment, models, samples, etc.	• Same as pictures, with added impact arising from the fact that they can be handled and examined by the student. • Supplement vision and hearing in learning. • Add realism.	• May be expensive to produce/operate. If improperly used, may distract class. • May be difficult to use with a large group where vision is limited by distance and the object is not large. • May not fit in well with other training methods or materials being used.

FIGURE 7

CHEMICAL AGENT TRAINING FILMS

TITLE	COLOR	LENGTH	PRODUCER	SOURCE	SUMMARY
[illegible]	No	6 min.	U. S. Army	U. S. Army	Use of Army's small expulsion grenade. Nomenclature and effects.
[illegible]	Yes	15 min.	Charles Cahill & Assoc. Inc. 5746 Sunset Blvd. Hollywood, Calif. 90028	Peace Officers' Association of the State of California 802 Forum Building, Sacramento, Calif., 95814. Sale or rent	Law enforcement techniques for riot control, including use of smoke and chemical agents.
[illegible]	Yes	10 min.	Royal Canadian Mounted Police	National Film Board Canada House, 680 Fifth Avenue, New York City, N. Y.	Proper handling of chemical agent equipment. Effects of CN and CS.
[illegible]	No	29 min.	U. S. Army	U. S. Army TF 19-1701	Dramatized incidents illustrate riot control activity. Brief segment on chemical agents.
[illegible]	Yes	25 min.	G. F. Cake & Co.	G. F. Cake & Co. 621 W. Garvey Avenue Montery Park, California	Proper use of Lake Erie chemical agent munitions and weapons.

CHAPTER NINE

Prestock, Procurement and Storage of Chemical Munitions

Decisions regarding the number and type of chemical munitions to be prestocked have generally been controlled by the availability of funds rather than any projection of tactical need. While it is true that procurement will always be limited by the amount of money allocated, the department that can present and support an intelligent statement of requirement is in a far better position to secure and make maximum utilization of additional funding. Also, regardless of the money available, the chemical agent program of any law enforcement agency can be improved by the adoption of more sophisticated procurement and storage practices. This chapter will be devoted to a discussion of these important topics.

PRESTOCK LEVELS

During May and June of 1968, the IACP conducted a survey of 119 law enforcement agencies to determine existing chemical munitions prestock levels. The results of this inquiry, as reported by 96 (81%) agencies responding, are summarized in Figure 1.

C S The 1968 survey revealed that 39, or 41%, of the 96 responding agencies had no C S agent on hand. The remaining departments shared some 24,862 units[1] of C S agent, with the District of Columbia accounting for a little less than half (10,813) of the CS units available.

Most of the C S agent was concentrated in the 21 cities of 500,000 to 1,000,000 population where 20,187 units of the total supply produced an index[2] of .87 as compared with the second ranking index of .16 reported by cities in the 100,000 to 250,000 population category.

C S and C N The most common agents in police use in the United States were either of the C S or the C N type, with the older C N agent in widest use at a ratio of almost 2 to 1. (45,845 to 24,862 units in reporting cities and counties)

Taken together, C S and C N agent supplies constituted a national index of .83 with a range of .07 to 5.21. Again, the highest index (1.50), was found in cities in the 500,000 to 1,000,000 population category. Even exclusive of the District of Columbia, these cities reported an index of .97 as compared with the next ranking index of .90 established by cities in the 100,000 to 250,000 group.

D M The compound D M is a nauseating or vomiting agent with severe physiological effects that greatly exceed C N and C S in magnitude and duration. Although D M is the third of three agents available to police

1/ For the purpose of the 1968 study, a unit of chemical agent was a single delivery container. For example, each grenade, projectile, or gas cartridge was counted as one unit.

2/ The number of units of agent per sworn personnel.

FIGURE 1 – CHEMICAL AGENT SUPPLY LEVELS
(JULY 1968)

Department Categories	Listed	Number Responding[1]	% Responding	Sworn Strength	No CS	CS Agent Total Units	CS Index[2]	CS & CN Total Units	CS & CN Index[2]	Index Range
Cities over 1,000,000	6	5	83%	28,975	2	1,249	.04	11,739	.41	.13-1.79
Cities 500,000 to 1,000,000	21	17	81%	23,126	4	20,187	.87	34,305	1.50	.14-5.21
(Excluding D.C.)		16		20,324	4	9,374	.46	19,683	.97	.14-3.61
Cities 250,000 to 500,000	27	24	89%	13,777	10	1,103	.08	9,242	.67	.21-1.43
Cities 100,000 to 250,000	47	35	74%	10,155	14	1,632	.16	9,106	.90	.15-4.91
Major Counties	5	4	80%	7,692	1	644	.08	5,663	.74	.34-1.62
Cities – Metro Criteria[3]	6	4	67%	596	3	6	.01	38	.06	.07-.45
Cities – Historical Criteria[4]	7	7	100%	695	5	41	.06	614	.88	.25-1.75
TOTALS	119	96	81%	85,016	39	24,862	.29	70,707	.83	.07-5.21

1 a/o 23 June 68
2 Units per sworn officer all reporting communities
3 Under 100,000, but near heavy population centers
4 Under 100,000, but with history of recent civil disorder

for riot control employment, it is not recommended for general riot use and consequently was not included with C S and C N in assessing agency supply levels. As a matter of general interest, a total of 926 units of D M were distributed among 19 of the reporting agencies.

Although it can safely be assumed that additional funds and emphasis on riot control capability have increased substantially the prestock levels indicated in the 1968 survey, subsequent informal inquiry suggests that while the prestock levels have in fact increased, the *variations* between agencies and categories of agencies have not changed significantly. In any event, few if any departments can today offer any rationale, other than budget limitations, for their particular prestock level. At a time when federal funds earmarked expressly for riot control are becoming available, the moment would seem to have arrived when agencies may be forced to predict, on some reasonable basis, their chemical munitions requirements.

DETERMINING NEED

The question of prestock level is not easily resolved and must, in the final analysis, be worked out for each jurisdiction by planners familiar with the many variables involved. However, to assist local planners and to provide some insight into the national need, the IACP has developed a recommended prestock index. This estimate was based upon the opinion of law enforcement agencies, the use of chemical munitions in actual civil disorders as revealed by field surveys, and similar projections developed by the military for riot control operations.

While the actual amount of chemical munitions employed will depend upon departmental policy, munitions availability, training, and the nature of the disorder, an index of 1.5 to 2.0 should provide a sufficient supply of chemical agent for at least 8 to 12 hours of riot control involving a liberal use of agent munitions. It should be stressed that this index is merely a guide and subject to all of the local variables discussed below.

Resupply. The time required to obtain a resupply of chemical munitions will influence the necessary prestock level. Departments located within reasonable driving distances from munitions manufacturers can generally stock at a lower level than those agencies that must rely on air freight shipments to replenish their supply.

When dealing with distributors or dealers, police officials should insure that promises of immediate delivery can in fact be honored. Many suppliers operate on a low overhead basis and tend to avoid actual warehousing of either equipment or supplies. On the other hand, if a local or regional supplier is willing and able to maintain a satisfactory inventory level there is a great deal to be said for allowing the munitions to expire on someone else's shelf.

The resupply picture may also be affected by local arrangements with the National Guard or by plans to utilize federal resources under existing loan programs. Departments not familiar with the provisions of the Department of Defense equipment and supply loan program can obtain this information from the IACP. To initiate planning under this program, police officials should contact the commanding officer of the nearest military installation. While prior planning may reduce the time required to arrange for the loan of military chemical munitions, some delay is inevitable and communities will continue to find it necessary to provide the resources required for that immediate response which has proved essential in the control of civil disorders.

Given the present short shelf life and high cost of chemical munitions, the most logical approach to prestock and resupply is the establishment of regional prestock centers under state-wide emergency plans. Such centers could be backed up by rapid air shuttle and resupply systems and perhaps even integrated with National Guard operations. State-wide planning of this sort should receive a high priority by the various state planning groups created under the Omnibus Crime Control and Safe Streets Act of 1968. The potential for increased riot control efficiency and dollar savings is impressive.

In the absence of state-wide or regional planning for chemical munitions resupply, mutual-aid agreements can be worked out between agencies. Although such agreements are frequently unreliable under conditions of widespread civil disorder, they are better than no agreement at all and may even work reasonably well under limited emergencies when adjoining communities are not directly threatened.

Community Characteristics. Prestock levels are also influenced by the size and nature of the population served. Obviously, the prestock index recommended above would not be applicable to either very large or very small cities and relatively small suburban communities would have to consider disorder potential arising from nearby cities or large educational institutions.

Communities with no history of civil disorder and low potential for such violence may be willing to prestock at lower levels than other cities, but previous tranquility has proven to be a poor justification for neglecting to plan for disorder control.

Departmental Considerations. The amount of chemical munitions required to deal with a civil disorder or even routine police operations is controlled to varying degrees by departmental *policy, planning* and *training.*

Departments with a clearly established *policy* calling for the use of chemical agents and delegating authority for their employment to a reasonable operational level will need to prestock accordingly. Experience suggests that agencies without clear policy and the necessary delegation of authority are far less likely to employ chemical munitions in any quantity. Policy restrictions on the kind of agent or munitions that may be utilized and limitations on when or where chemicals can be employed will also affect both the quantity and the type of munitions to be stocked.

The level of *planning,* in addition to policy, must be taken into consideration. If policy calling for the use of chemical munitions is to be implemented, there must be planning to assure that the munitions will be available when and where needed and that all involved personnel will be supplied with protective masks. A department deficient in protective equipment and with no plan to get chemical munitions into the field when needed is not really ready to develop any kind of an intelligent prestock index.

Finally, munitions requirements are dependent upon the degree of proficiency of the personnel involved in the operation. Well trained and supervised officers can achieve the same results with far fewer munitions than would be needed by unskilled and poorly controlled personnel. There is great potential for waste in the indiscriminate use of chemical munitions even though the immediate objective might be realized. The use of a $12 projectile to achieve the same results that could be achieved with a $4.00 grenade or the use of 4 grenades when 1 grenade would be sufficient might be justified on the basis of expediency, but such errors in judgment can and should be minimized by proper training and control.

SELECTING DELIVERY SYSTEMS

Prestock planning involves not only a decision on quantity of munitions, but also the question of what types of delivery systems are required to provide sufficient flexibility to permit the use of chemical agents under all or most tactical conditions for which they are appropriate.

Although delivery systems were discussed in some detail in Chapter Three, Figure 2 summarizes common munition applications and suggests the generally accepted delivery system of choice for various tactical situations. While there might not be universal agreement on the munition selection recommended in Figure 2, it does provide a systematic approach to determining munition needs.

The 1968 survey, referred to earlier, revealed a national prestock ratio of about 70% grenades and 30% projectiles.[1] This ratio would appear to be a reasonable one for general planning purposes although the exact ratio for any department will depend upon many of the same factors that influenced the prestock index discussed above.

The grenade/projectile ratio will also be influenced to a large extent by the availability of 1.5 caliber riot gas guns within the agency. In operations against large crowds the presence of a flanking or headwind may require that agent be projected upwind. This can be accomplished either by the use of unstabilized projectiles fired from the 1.5 caliber riot gas gun or by grenades launched from the 12 gauge riot shotgun. A shortage of the gas guns would require a larger percentage of grenades and grenade launching equipment.

PRESTOCK LIMITATIONS

The greatest obstacle to the development of adequate chemical agent supply levels is the high cost and short shelf life of those munitions currently available for police use in the United States. While the cost of producing

1/ The 1968 survey did not include bulk dispensers and the wand was not on the market at that time.

FIGURE 2 – COMMON MUNITIONS APPLICATIONS

	DELIVERY SYSTEMS										
	GRENADES			PROJECTILES							
Target	Standard P*	Standard E*	Small P	Stabilized P	Stabilized E	Unstabilized P	Unstabilized E	Wand P	Cartridges E	Bulk Dispenser	Aerosol Irritant Projector
Large Crowds Headwind	1 ✓	1 ✓	1 ✓		✓	✓					
Following Wind	✓	✓	✓							✓	
Contact Confrontation										3 ✓	
Small Groups			✓						✓		
Barricaded Criminals (Sniper)		2 ✓			✓						
Sit-in Demonstrations (Non violent)								✓		3 ✓	
Self-defense (Individual arrest)											✓

* P - Pyrotechnic (Burning) Dissemination
E - Expulsion (Bursting) Dissemination

1 Launched
2 Select Low Fire Risk Grenade
3 Especially The Fog Type

and marketing civilian chemical munitions is difficult to estimate, dealer commissions of 25% to 40% of list price suggest that actual production costs are not high.

Whether or not the price structure of chemical munitions is justifiable, the current three year warranted shelf life is unreasonable and in most cases artificially imposed. In many instances this shelf life could and should be extended without major design innovation or substantial cost increase. In fact, a six year shelf life would represent, for most departments, an actual 50% cost decrease since munitions usually go out of date before they can be used in field operations.

The comparison of standard pyrotechnic grenades summarized in Figure 3 reflects the cost/shelf life differential between the military M7A3 grenade and similar commercial units. This is not to imply that civilian munitions can be marketed at federal procurement costs, but it certainly suggests that, at least in the case of burning grenades, a reliable, long-life, unit can be produced at a reasonable cost. It is only a matter of time until some enterprising manufacturer offers munitions with an extended shelf life or police agencies develop purchase specifications that will produce the same result.

In any event, it is clear that there will have to be some "give" in the cost/shelf life characteristics of chemical munitions if law enforcement agencies are going to prestock at the levels necessary to deal with an era of civil disorder.

FIGURE 3 – COMPARISON OF STANDARD PYROTECHNIC GRENADES

Pyrotechnic Grenades	Filler Weight (grams) CS	Other	Total	Grenade Weight (ounces)	Agent Emission Time (seconds) Reported	Actual[1]	Dimensions (inches) Height	Diameter	Body Material	Exit Ports Top	Base	Sides	Shelf Life (Yrs.)	Catalog Cost (1/69)	Shelf Cost Per Yr.
Military M7A3	128	211	339	16	15-35	[2]	5¾	2¼	Steel	√	√		8	$3-4	$ .50
Federal Spede-heat	104	276	380	20	25-35	71.95	6¼	2-5/8	Alum.	√	√	√	3	$11.30	$3.77
Lake Erie Contin-uous Dis-charge	106	179	285	15½	25-30	152	6½	2-5/8	Alum.	√		√	3	$11.30	$3.77
Penguin Burning Grenade	69	161	230	14	40	[3]	5¾	2½	Steel	√	√		3	$ 9.95	$3.32

[1] Per IACP field evaluation.

[2] Not evaluated.

[3] CS loading not available for evaluation. CN unit average burning time 40 seconds.

PROCUREMENT

Once a decision has been made regarding the number and types of chemical munitions to be stocked, police planners must decide which specific products are to be purchased or at least develop specifications that will guide the procurement process. Ideally, law enforcement agencies would develop performance requirements for chemical munitions based on their specific needs. Unfortunately, very few police departments purchase sufficient quantities of chemical munitions to enable them to influence the performance characteristics of such products. In the absence of any unified police purchasing power of sufficient volume to influence product design, it would seem that perhaps consideration should be given to the creation of some form of national advisory council that would develop chemical munitions material standards and work with commercial manufacturers to encourage consideration of police requirements.

As long as the police are unable to establish procurement standards, they can only select from existing products by developing evaluation procedures that will allow them to choose between competitive items. While it is true that such important munition characteristics as effective airborne concentration, formulation, shelf life, and sensitivity to transport and storage conditions are beyond the evaluation capability of most law enforcement agencies, there are other performance features that can and should be compared before a decision is made to order a particular chemical munition.

Grenades, projectiles, aerosol irritant projectors, and bulk dispensers can all be field tested to determine the extent to which they meet some of the manufacturers specifications and to observe how they compare with competitive products. The burning time, temperature, and fire potential of pyrotechnic munitions can be measured in simple field tests. The load loss, fragmentation and fire risk of expulsion munitions are also subject to simple evaluation. Failure to function and malfunction ratios are easily established when it is possible to test an adequate munition sample. All of these characteristics are important and their evaluation should assist substantially in product selection. An example of a field evaluation procedure is contained in Appendix B, *Field Evaluation of Channel Agent Grenades.*

While it is true that the police are now largely restricted to a choice between existing products, the eventual development of specifications would involve at least the following considerations for grenades and projectiles, which represent the bulk of law enforcement chemical munitions purchases.[1]

Container. Steel, aluminum, plastic, rubber, cardboard, etc.

Color. Munitions color. The generally accepted color coding is red for CN, blue for CS, green for DM, and yellow for smoke.

Labeling. What instructions or warnings should appear on the munition and its packing container? Should devices be furnished with identifying features that will permit identification by touch during darkness?

Packing. What kind of individual and bulk packing should be provided? What levels of protection against shock, vibration, heat, and humidity should be provided? How rapidly can containers be opened and how easily can they be resealed?

Weight and Dimension. What size are containers? Will they operate with existing equipment such as shotguns, riot gas guns, and grenade launchers? How much does the munition weigh?

Payload. What is the total payload weight plus or minus five grams? How much of the payload, within five grams, is chemical agent? What does the non-agent portion of the payload consist of?

Fuze. What is the absolute minimum fuze delay time? What is the average fuze delay? What is the resistance to withdrawal of the pull ring in grenades?

Discharge. In pyrotechnic munitions, how long, within 10 seconds, will burning take place? What fire risk is involved? What is the temperature of the munition body during discharge? What effective airborne concentration is produced? What is the particle size distribution? In expulsion munitions, what per cent of the loading is released? What fragments are produced and what is their velocity and range?

Range. For projectiles, what are the maximum and effective ranges? What is the muzzle velocity? For grenades, can they be launched? If so, how far and with what kind equipment? For barricade projectiles, what is the penetrating power as stated in practical terms?

Shipping and Storage. Shelf life and storage limitations. Acceptable temperature and humidity ranges. Nature of guarantee or warranty.

CHEMICAL MUNITIONS STORAGE

It is generally agreed that proper handling and storage of chemical munitions under ideal conditions can prolong their useful life several years beyond the three year period warranted by most manufacturers. Unfortunately, few police agencies are presently equipped with the facilities necessary to provide ideal storage conditions. Since inadequate storage conditions reduce normal shelf life and produce malfunctions, it would seem that any department with a substantial investment in chemical munitions inventory would realize a considerable financial saving by providing suitable storage facilities and developing effective chemical munitions handling procedures.

1/ Specifications for aerosol irritant projectors are discussed in Chapter five.

There would also appear to be a need for some simple research into ways in which law enforcement agencies could extend the predicted shelf life of their munitions, especially the grenades, which are usually not complex devices. For example, most malfunctions in out-dated grenades result from defective fuzes and could be avoided by replacing all grenade fuzes after three or four years of shelf life. Except for the Lake Erie grenades, which employ a design feature that incorporates some of the fuze components in the grenade body,[1] most grenade fuzes can be easily unscrewed from the fuze adaptor and replaced at a fraction of the cost of replacing the grenade. Replacement fuzes can be obtained from manufacturers at costs ranging from $.50 to about $1.50.

ENVIRONMENT

The two most critical storage conditions are humidity and heat. In tropical areas where both are high, the shelf life of chemical munitions is likely to be much shorter than anticipated. Ideally, storage facilities would be maintained at a temperature of 60° with a 50% relative humidity. Obviously, the maintenance of a year-round environment of this kind in most parts of the world would require an air conditioner and perhaps even additional humidity control equipment. In any event, storage areas must be as cool and dry as possible and extreme temperature variations should be avoided.

Humidity. For most munitions, the individual sealed containers in which they are shipped from the factory provide protection against moisture and, whenever possible, munitions should be stored in these protective packages. Since it is unlikely that defective new munitions can be identified by sight, the practice of opening each container upon receipt could be avoided. Procurement specifications should require that *complete* identifying information and expiration date appear on the outside of each sealed unit container. If it is absolutely necessary to open these containers, they can be carefully resealed as soon as possible. Even external shipping cartons and drums provide some humidity protection and should be used for storage.

The importance of packaging is suggested by the fact that the longer life and greater insensitivity to storage conditions of military riot control munitions are frequently attributed to the manner in which these devices are packaged. While it is doubtful that this is the only factor involved, it is interesting to note that the present military container adds only about sixty cents to the cost of a grenade – certainly a good investment even if it contributes only in part to increased product life, performance, and storage flexibility.

Heat. High temperatures have an adverse effect on chemical munitions. Heat deteriorates and reduces the reliability of the chemical components of primers, propelling charges, detonators, and bursters. For example, primers subjected to prolonged high temperatures become insensitive to pressure and may fail to function.[2] The need to avoid excessive heat during storage makes it undesirable to carry chemical munitions in the trunks of police vehicles for prolonged periods during warm weather. When it is necessary to carry munitions in vehicles under such conditions and the more durable military munitions are not available, the stocks can be rotated periodically to reduce heat deterioration.

The same principle of rotation can be used when some munitions must be stored at precinct stations or other points where conditions are not adequate. If these stocks can be rotated monthly by returning them to adequate storage and replacing them with fresh munitions, better performance can be anticipated.

ARRANGEMENT

Most chemical munitions can and should be stored in their original sealed containers as suggested above. While most agencies prefer to keep a certain number of munitions unpacked for fast access under emergency conditions, this practice should be kept to a minimum and these munitions should also be rotated periodically

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1/ The AAI MPG grenades are also an exception, but these munitions are unique in that they are supplied with a six year shelf-life guarantee.

2/ Swearengen, Thomas F. – *Tear Gas Munitions,* Charles C. Thomas, Publisher.

and resealed in their original containers. Grenades removed from their containers and carried in cloth bags will rub together and frequently dislodge exit port seals, accelerating the action of moisture on the grenade unless the seals are promptly replaced.

In storage areas, munitions are separated by type and arranged so that older stocks will be used first. Outdated, unreliable, or practice munitions should never be stored with active supplies. For departments with chemical agents stored in several different areas, a central index or inventory must be maintained to reflect the location, type, and expiration or purchase date of all munitions. Records of this sort can be kept on special forms or even on inexpensive 3x5 file cards. The exact format is not important as long as the necessary control information is recorded.

HANDLING

Reasonable care should always be exercised in the handling of chemical munitions. Even with good packaging it is possible to damage munitions by rough or violent handling and the more complex the device the greater the likelihood of shock damage. Projectiles with impact fuzes require special care in the manner in which they are treated during shipment and storage. As with most chemical munitions, the immediate concern is not that a device will detonate during handling, but that damage will eventually cause the unit to malfunction under tactical conditions when performance could be critical. While properly packed chemical munitions do not require delicate handling, reasonable care would mean avoiding such practices as dropping or throwing cases of munitions even for short distances or carrying individual unit containers loose in the trunk of a car where they will be tossed about by normal vehicle motion.

Qualified personnel should inspect chemical munitions periodically, especially those items that have been removed from their shipping containers for rapid access. Since most munitions leak or leach to some degree, the odor of agent is normal in storage areas and should not necessarily be regarded as a sign of deterioration. On the other hand, any visible rust or serious corrosion suggests damage from humidity or chemical reaction and is sufficient reason to remove the item from service. With grenades, fuzes can become loose in shipment or handling and should be tightened firmly to seal out moisture. Any missing exit port seals can be replaced with plastic adhesive tape. Badly dented munitions should be removed for destruction.

DISPOSAL

The disposal of defective or out-dated chemical munitions is normally achieved by burning. As suggested earlier, the point at which munitions become out-dated by virtue of the manufacturers warranty and the point at which they become unserviceable are two different things.

In deciding when munitions become unserviceable, as opposed to simply being out-dated, the criteria would appear to be safety and reliability. The question becomes what is the risk of injury to police personnel if a unit malfunctions; and how important is it, from a tactical point of view, that every munition functions at full efficiency. If these criteria are accepted, they can provide a basis for the development of munitions disposal guidelines that are relatively independent of the current automatic three year dating system.

Safety. Since the fuze components of munitions are usually the first to deteriorate, the greatest safety risk would be encountered in explosive munitions where fuze deterioration might result in rapid or instant detonation. Premature detonation could result, for example, in expulsion grenades exploding in an officers hand or immediately after release. Pyrotechnic or burning munitions, on the other hand, are unlikely to seriously injure an officer even if they do ignite prematurely. Thus the burning devices stored under adverse conditions or retained beyond their expiration date can be used with substantially less safety risk than can the exploding munitions.

Efficiency. Old or defective munitions may fail to operate or may operate at reduced efficiency. In either case the only real danger is to police personnel that might be injured by the premature detonation of an explosive device. Unlike standard firearms ammunition, where reliability may be essential, chemical riot control munitions are very rarely employed in a self-defense situation. Consequently, loss of efficiency or functional failures may be tolerable in the case of chemical munitions and, if this is true, then the non-explosive devices could be employed well beyond their specified shelf life.

When munitions are stored under less than satisfactory conditions or "pushed" beyond their shelf life, qualified personnel must inspect the stock regularly and at least a 5% random sample should be test fired in order to determine when reliability has fallen below an acceptable level. An "acceptable level" being whatever an agency has decided it is willing to tolerate in the way of failures or malfunctions.

Destruction. Munitions that either fail to function or malfunction must often be recovered and transported prior to final disposal. The most serious hazard arises in connection with the expulsion devices that employ an explosive device for dissemination. There is always a danger that they will explode in the hand if picked up by curious children or by police officers for disposal. Unless an explosive disposal unit or bomb squad is available, the safest field expedient is for a masked officer to pick the projectile or grenade up with a shovel and drop it into a container of water for removal to a remote location for destruction. A period of 30 minutes following release should be allowed before any attempt is made to deal with defective explosive munitions. The explosive grenade can, of course, be neutralized by unscrewing and removing the fuze assembly, but the risk of injury involved rarely justifies employing this technique.

Burning munitions, on the other hand, present less of a disposal problem. This type of misfire can be approached and retrieved with relative safety after five minutes have elapsed from the time of release. There is, however, no reason why they cannot be handled in the same manner as explosive devices to provide even a greater margin of safety.

Federal Laboratories recommends the following special handling technique for their expulsion projectiles:

> The malfunctioning projectile should be carefully picked up and *held with the fin end down.* This position will allow the firing pin to fall back against the rear closing disc. While holding it in this position, using a piece of wire (or thin twig) gently work the firing pin around until the hold in the firing pin lines up with the hole in the fuze body.
>
> When the holes are lined up, place the wire (or twig) through the hole in such a way that it cannot be dislodged. The projectile can then be safely transported and ultimately tossed into the fire.

Since most law enforcement agencies do not find it necessary to destroy large quantities of munitions or to conduct disposal operations on a regular or frequent basis, temporary facilities are all that are normally required.[1] A burning pit about 3 feet square and 3 feet deep should be constructed in a location where the risk of fire is low and where the agent-loaded smoke will not disrupt nearby activities. A fire is started in the bottom of the pit and burning grenades are fed into the pit several at a time until all have been destroyed. Because of their explosive nature, expulsion grenades are usually inserted one at a time to reduce the scattering of the fire outside the pit. If possible, projectiles are separated from their bases before burning and destroyed singly. A cover over the pit will aid in preventing projectiles from being blown clear during destruction. Naturally, disposal personnel will require protective masks and should work in teams of at least two men.

1/ For details of a more elaborate destruction pit see Swearengen, Thomas F., *Tear Gas Munitions,* Chapter 11.

APPENDIX A

Chemical Agents and The Law

by
Neil C. Chamelin

In conjunction with the International Association of Chiefs of Police Chemical Agents Program a study was conducted of civil actions arising from the police use of chemical agents. In order to draw any conclusions on this subject it was necessary to discover what the courts have said in the past. Although an exhaustive search was conducted, no claim is made that all the appellate cases involving police use of chemical agents were found. The number of cases still in the trial courts or those which have not yet come to trial is unknown and impossible to determine. This report deals solely with cases that have reached the appellate level.

It is interesting to note that this research disclosed a total of only fifteen cases reaching the appellate courts in the United States covering a period of 35 years from 1934 to the present. Of these fifteen, two involved a single case that was appealed twice. None of the cases were decided by federal courts and only four of them arose during the 1960's. Thirteen of the fifteen cases involved procedural questions on appeal not dealing with the merits of the claims. Seven of these resulted in a dismissal and trials or new trials were ordered in the other six. There is no indication that any of these cases were again appealed after trial. This leaves only two cases reviewed in the appellate courts on their merits. The facts and holdings of these cases may be of interest to the reader.

The first case was decided in 1948, by the Supreme Court of Arizona. In *Caudoin v. Fuller,* 67 Ariz. 144, 192 P 2d 243 (Sup. Ct., 1948), a sheriff and his deputy were sued for wanton and reckless assault. It. The deputy arrested the plaintiff at a bar and restaurant for disturbing the peace. From a distance of approximately three feet, the deputy fired a tear gas gun into the plaintiff's face. Testimony indicated that the deputy announced his identity and advised the plaintiff he was under arrest. The gun used to fire the tear gas was issued by the sheriff's office and the deputy received instructions on its use. The plaintiff was not given medical aid until the following morning. He attempted to care for himself by swabbing his eyes with a dirty sock, moistened from water in the toilet bowl in his cell. The trial court awarded a judgment for the plaintiff after finding that the plaintiff was not resisting arrest at the time the tear gas was used and that the deputy acted unreasonably and with excessive force. The appellate court affirmed the judgment on the merits.

In 1961, the New York Court of Claims in *Titcomb v. State of New York,* 30 Misc. 2d 902, 222 N.Y.S. 2d 596, found the State of New York liable for negligently failing to instruct a state police officer in the proper use of tear gas. In that case the officer, while investigating a case of property destruction, approached decedent's house and was granted access. The decedent refused to come out of his room. Concerned over the decedent's mental condition, officers threw a tear gas canister into the room in an attempt to remove decedent. Expert testimony indicated the decedent suffered excruciating pain from the effects of the gas on his lungs and respiratory tract. The pathologist who performed the post-mortem examination testified that the entire respiratory tract showed destruction of living cells and the effects of anoxia.

Issues

Based solely on these two cases, it would be unwise to assess the overall civil liability for police use of chemical agents. However, it might be enlightening to examine the issues that caused these fifteen cases to reach the appellate courts.

One of the prime issues involved in many of these cases relates to the use of reasonable force to affect a lawful arrest. The courts in affirming or reversing these cases indicate that the same tests are to be applied to chemical agents as would be applied in the use of any other kind of force in affecting arrests. Thus, the question to be asked in any particular case is whether, under all the circumstances, the officer was justified in using chemical agents. Any answer to this question will depend upon the case rulings in the various jurisdictions. Officers should know the law of their own states on the use of force to effect arrests.

A second major issue raised by these cases involves the liability of a state or municipality in cases where employees negligently or intentionally use tear gas where its use is not warranted. Of course, this problem is of little direct concern to the police officer but nevertheless is an important area of the civil law. It might be noted here, however, that in most cases concerned with the liability of the state or municipality, the individual officer is also sued for his negligent acts.

Types of Chemical Agents and Weapons

Only nine of the cases found mentioned the type of weapon used to project the tear gas. In one case a well known canister type tear gas was used. Two of the cases involved the use of fountain pen tear gas projectors and the other six mention only tear gas guns. One of those six however, identifies the weapon as a .38 – special tear gas gun. Three of the cases described the instruments used as follows: "It was five and one-fourth inches in length and weighed one and six-tenths ounces. It fired a .38 caliber cartridge." A second said, "the projectile was a metal shell, seven inches in length and one and one-fourth inches in diameter." A third case identified the weapon as a "Hercules Tear Gas Fountain Pen Projector", made of metal with an overall length of five inches, a barrel length of one and three-fourths inches, weighing two ounces, and it fired a .38 caliber tear gas cartridge. The Titcomb case cited above, involved a Federal "112 Spedeheat" canister loaded with solid crystalline chloroacetophenone.

Injuries

Six of the cases found alleged permanent damage as a result of the police use of tear gas. Five of these resulted in the loss of eyesight and the other produced death. In the Titcomb case, expert testimony established that the tear gas was the cause of death. In another case, the officer fired the tear gas gun from within six inches of the plaintiff's face causing total loss of one eye and 75% loss of vision in the other eye. Three of the cases only state that the tear gas guns were fired and "put out plaintiff's eye". The fifth case alleges only that the plaintiff lost his sight in one eye as a result of the tear gas being fired.

Conclusion

As a general rule, the cases indicate that tear gas or chemical agents can legally be used if officers are instructed in the proper handling and use of these devices. But, like any other tool, they can be highly destructive when improperly operated. Perhaps the lack of cases in this area speaks well for the training law enforcement officers receive in the use of chemical agents, but it should be emphasized that negligence in the use of these agents can lead to civil liability.

VILLAGE OF BARBOURSVILLE V. TAYLOR
174 S.E. 485 (W.V. Sup. Ct. App. 1934)

Action: For battery, for excessive use of force in making an arrest.

Facts: An officer arrested plaintiff for drunkeness and disorderly conduct. He fired a tear gas gun that put out plaintiff's eye.

The instrument was a "fountain pen tear gas gun". It was five and one-fourth inches in length and weighed one and six-tenths ounces.It fired a .38 caliber cartridge.

The trial court found for plaintiff. Defendant appealed.

Held: Reversed and remanded for new trial. The trial court erred in not instructing the jury that an officer in making an arrest is presumed to act in good faith.

KENT V. SOUTHERN R. Y. CO.
184 S.E. 638 (Ga. Ct. of App. 1936)

Action: Battery, against a railroad company.

Facts: In a labor dispute, plaintiff was in a crowd of strikers blocking a railroad track. At the request of an employee of the railroad the chief of police came to the area. The officer fired a substance from a gun into the crowd. It was not alleged that the substance was tear gas, but the court said, "the result alleged showed it was somewhat similar".

A motion to dismiss the complaint was granted and plaintiff appealed.

Held: Affirmed, there was no allegation that the chief of police acted with unreasonable force and he was acting as an employee of the railroad.

MARTINEZ V. KILDAY
117 S. W. 2d 151 (Tex. Ct. of Civ. App., 1938)

Action: Suit for injunctive relief.

Facts: Members of a labor union sought injunctive relief to prevent police force from being used in connection with a labor dispute.

The appellate court sanctioned police use of tear gas and other measures to dispel threatened violence by upholding the trial court's denial of an injunction. The court permitted use of tear gas in "harmless quantities", in order to disperse crowds and avert what the police could reasonably regard as threatened violence.

Held: Denial of injunction affirmed.

HAGEDORN V. SCHRUM
283 N.W. 876 (Iowa Sup. Ct. 1939)

Action: Battery, against a town and town marshal.

Facts: The city furnished defendant a tear gas gun for use as an officer of the city. Plaintiff alleged that the officer willfully and maliciously assaulted him with the tear gas gun. The plaintiff alleged that he was injured on his head, around his eyes and on his face. The trial court granted the city's motion to dismiss. Plaintiff appealed the trial court's decision.

Held: Motion to dismiss affirmed. The appellate court held that an officer was the agent of the public and that a municipality that employs him is not liable for his unlawful and negligent acts.

PFANNENSTIEL V. DOERFLER
105 P 2d 886 (Kan. Sup. Ct. 1940)

Action: For personal injuries for use of unreasonable force in making an arrest.

Facts: Plaintiff was arrested by two deputies under a warrant charging disturbance of the peace. Plaintiff alleged that one of the deputies discharged a tear gas gun within six inches of his face and that gunpowder and gas caused a total loss of one eye and a 75% loss of vision of the other.

Plaintiff further alleged that the sheriff negligently failed to provide medical treatment when plaintiff was delivered to the jail.

The sheriff contended, in a motion to dismiss, that he was not liable for the actions of the deputy because he was not acting in the capacity of deputy sheriff and that there was no allegation in the complaint of fault or misconduct on the sheriff's part.

Motion to dismiss was denied; the sheriff appealed.

Held: Denial of motion to dismiss affirmed; a sheriff is liable for misconduct of his deputies; a sheriff having lawful custody of a prisoner is under a duty to treat the prisoner properly.

MACDONALD V. OGAN
104 P. 2d 1106 (Idaho, Sup. Ct. 1940)

Action: Battery, against a deputy and watchman and the corporation that employed the watchman.

Facts: While on his rounds as a watchman, a deputy sheriff came upon a fight in which plaintiff was involved. The deputy repeatedly warned the parties to cease fighting. He fired a "38-special" tear gas gun and put out plaintiff's eye.

The jury returned a verdict for defendant. A motion for new trial by the plaintiff was granted.

Held: Affirmed.

MACDONALD V. OGAN
129 P. 2d 654 (Idaho, Sup. Ct. 1942)

Action: Battery

Facts: On the second time before the appellate court, the court indicated that it was clear that plaintiff was "maliciously and willfully" disturbing the peace and he refused to desist when requested to do so by the deputy.

The trial court, in the second trial, found for the plaintiff. The company that employed the deputy as a watchman appealed.

Held: The action was dismissed as to the company and remanded for a new trial to determine the officer's liability as an individual.

HOGLE V. RELIANCE MANUFACTURING COMPANY
48 N. E. 2d 75 (Ind. App. Ct. 1943)
(Rehearing denied: 48 N. W. 2d 999)

Action: For conspiracy, intentional tort and negligence.

Facts: Plaintiff, an employee of Reliance Manufacturing Company, was engaged in a labor dispute. The sheriff deputized a number of individuals to protect the company's property. One of these deputies fired a tear gas gun into a crowd of which the plaintiff was a member. The tear gas projectile struck the plaintiff in the head and penetrated his skull. The projectile was a metal shell, seven inches in length and one and one-fourth inches in diameter.

The trial court granted the defendant's motion to dismiss. Plaintiff appealed.

Held: The appellate court overruled the motion to dismiss and ordered a trial.

CAUDOIN V. FULLER
67 Arizona 144, 192 P. 2d 243 (Sup. Ct. 1948)

Action: Wanton and reckless assault against sheriff and his deputy.

Facts: Defendant arrested plaintiff at a bar and restaurant, for disturbing the peace. From a distance of approximately three feet he fired a tear gas gun into his face. Testimony indicates that defendant stated to plaintiff: "You are under arrest. I am a deputy sheriff". The gun was issued by the sheriff's office and defendant was given instructions about its use.

Plaintiff was not given medical aid until the next morning. He attempted to care for himself by swabbing his eyes with a dirty sock, moistened from water in the toilet bowl.

The trial court made findings of fact that the plaintiff was not resisting arrest or attempting an aggressive act and that the deputy acted unreasonably and with excessive force.

The trial court found in plaintiff's favor.

Held: Affirmed.

SALAZAR V. TOWN OF BERNALILLO
307 P 2d 187 (N. M. Sup. Ct. 1956)

Action: Assault and Battery.

Facts: Plaintiff was attending a social function and was standing at the bar drinking. The mayor of the defendant town approached plaintiff and an argument over the city administration ensued. After the discussion, plaintiff alleges that the mayor directed a deputy to shoot him with a tear gas gun. Plaintiff lost the sight of one of his eyes and suffered other injuries. The jury found, in answer to special interrogation, that the plaintiff was not conducting himself in a peaceful, law abiding manner at the time of the assault upon him.

The town was the only defendant. The jury returned a verdict in the plaintiff's favor. The town appealed.

Held: It was not within the mayor's power to order violent force when unwarranted by the circumstances. The mayor ceased to act on behalf of the town. The town was without liability. Reversed.

BUKATY V. BERGLUND
294 P 2d 228 (Kansas Sup. Ct. 1956)

Action: Wrongful death, against the county attorney, sheriff, chief of police, and a highway patrol trooper.

Facts: Decedent was mentally disturbed. He was placed in jail where he caused a disturbance. Tear gas was used in an attempt to evict decedent from the cell but it had no effect, apparently because decedent broke the cell windows.

The defendants then discharged "refrigerator" gas into the cell to subdue decedent. Testimony indicated that the gas was sulfur dioxide. A post-mortem examination indicated that the gas was the cause of the decedent's death.

A motion to dismiss was granted at the end of the plaintiff's case. Plaintiff appealed.

Held: Reversed; the question of whether the use of such a deadly gas was reasonable under the circumstances presented a factual issue.

TITCOMB V. STATE OF NEW YORK
30 Misc. 2d 902, 222 N.Y.S. 2d 596
(N.Y. Ct. of Claims 1961)

Action: Wrongful death, for negligence against the State of New York.

Facts: A state police officer, while investigating a case of property destruction, approached decedent's house. Members of decedent's family allowed the officer access to the house, but decedent refused to come out of his room. Concerned over the decedent's mental condition, officers threw a tear gas canister into the room in an attempt to remove decedent.

The canister used was a 112 Spedeheat; loaded with solid crystalline chloroacetophenone and manufactured by Federal Laboratories Inc.

Expert testimony indicated decedent suffered excruciating pain from the effects of the gas on his lungs and respiratory tract. The pathologist who performed the post-mortem examination testified that the entire respiratory tract showed destruction of living cells and the effects of anoxia.

Held: For plaintiff. The use of tear gas was not justified and the state was negligent in failing to instruct officers in the use of tear gas.

DEMARS V. TOWN OF MANSURA
166 So. 2d 328 (La. Ct. of App. 1964)

Action: Negligence, against town and its assistant marshal, for use of tear gas.

Facts: Plaintiff alleged the assistant marshal released tear gas around his face and eyes, causing him injury. The trial court dismissed the action against the city. Plaintiff appealed.

Held: The assistant marshal was acting purely within a governmental function. The town was immune from liability for torts of the officer.

LUVAUL V. CITY OF EAGLE PASS
408 S.W. 2d 149 (Tex. Ct. of Civ. App. 1966)

Action: Negligence, nuisance, or battery.

Facts: The plaintiff was arrested by a city police officer and taken to the county jail. A disturbance ensued at the jail. The disturbance was not of plaintiff's making.

The police officer shot plaintiff with a tear gas gun at close range. Plaintiff lost the sight of both eyes.

After plaintiff was shot, medical aid was not furnished for eight hours.

Summary judgment was granted in favor of defendant. Plaintiff appealed.

Held: City was immune from liability for torts of employees committed in exercise of governmental functions.

WALL V. ZEEB
153 N.W. 2d 779 (N.D. Sup. Ct. 1967)

Action: Assault and battery.

Facts: Defendant was an on-duty police officer. Plaintiff was sitting in his car when defendant approached the parked automobile. Plaintiff was asleep or unconscious with an open can of beer in his hand. Plaintiff refused to disclose his identity. Defendant contends he placed plaintiff under arrest. An altercation occurred, plaintiff ran into a house owned by his mother. Defendant pursued plaintiff, armed with the tear gas gun and a flashlight. Defendant tried to remove plaintiff from the house and during a scuffle the tear gas projector discharged.

The tear gas instrument used by defendant was a "Hercules Tear Gas Fountain Pen Projector". It was made of metal, had an overall length of five inches, a barrel length of one and three-fourth inches, weighed two ounces, and fired a .38 caliber tear gas cartridge.

In the trial court the verdict and judgment was in plaintiff's favor.

Defendant appealed.

Held: Reversed and remanded for a new trial. The court erred in instructing the jury that a tear gas gun was a "firearm" and that defendant had the burden of proving he acted reasonably.

APPENDIX B

Field Evaluation of Chemical Agent Grenades

As part of the Chemical Agents Program conducted by the I.A.C.P. for the Law Enforcement Assistance Administration of the U. S. Department of Justice, a field evaluation of commercial riot control agent grenades was conducted during March 1969. Facilities at Fort Belvoir and the Fairfax County Police Department in Virginia were used to evaluate several selected characteristics of 13 chemical agent grenades currently available for police use in the United States.

GRENADES EVALUATED[1]

Designation	Model/Catalog Number	Quantity	Agent
PYROTECHNIC			
Brunswick Skitter Grenade	5001	24	CS
Federal Pocket Grenade	109	24	CS
Federal Spedeheat Grenade	555	24	CS
Federal Triple Chaser	515	24	CS
Lake Erie Continuous Discharge	2CS	24	CS
Penguin CN/Smoke Grenade	G3	24	CN
EXPULSION			
AAI Multipurpose Grenade	MPG 120	24	CS
Federal Blast Dispersion	514	24	CS
Federal Disintegrating	520	24	CS
Lake Erie Jumper Repeater	1 CS	24	CS
Lake Erie Mob Master	7 CS	24	CS
Lake Erie Model 34	4 CS	24	CS
Penguin Baseball Grenade	G-1CS	24	CS

No attempt was made to define and evaluate *every* important characteristic of these munitions. In fact, effective airborne concentration, which is perhaps the most critical feature of all, cannot be measured or even estimated without elaborate and expensive laboratory testing facilities. What was intended here was the collection of certain observable performance data that relate to the tactical use of chemical agent grenades. Much of the information developed by this project was previously unavailable, incomplete or conflicting.

The procedures employed in this evaluation were simple and well within the ability of any law enforcement agency to duplicate. Although the expense of munitions generally precludes extensive field testing and evaluation by all but the largest departments, the procedures suggested in this report can serve as a guide for the development of at least minimal evaluation programs to assist law enforcement personnel in selecting riot control chemical munitions.

[1]The Lake Erie Blast Dispersion grenade, which has been discontinued by the manufacturer, was not evaluated. The new Lake Erie Mighty Midget and Northrop Rubber Ball grenades were not on the market at the time the other munitions were purchased during February 1969 and consequently were also not included in this evaluation series.

PYROTECHNIC GRENADES

Pyrotechnic or burning dissemination is achieved by mixing a granulated chemical agent with an appropriate fuel. Upon ignition, the fuel burns and vaporizes the agent. The agent vapor exits from the grenade with the smoke and the termination of smoke emission under internal pressure. The continued smouldering or the smoke until ultimately dissipated.

For grenades employing burning dissemination, three major characteristics were examined. Buring time, functioning, and temperature were evaluated for the three standard burning grenades, the multiple unit Triple Chaser, and two miniature grenades (Figure 1).

Burning Time. A standard stop-watch was used to measure the elapsed time between the first appearance of smoke and the termination of smoke emission under internal pressure. The continued smouldering or smoke drift from exit ports was not included as burning time. When actual burning time was compared with the emmission time specified by the manufacturer, it was evident that all but one of the standard pyrotechnic units burned for considerably longer than predicted.

A longer burning time could be either an advantage or a liability, depending upon the tactical situation. The extended burning period will permit more time for the return of the grenade by members of the crowd, but on the other hand, the more quickly a grenade burns, the more frequently it will have to be replaced on a release line when a given concentration is being maintained. In any event, manufacturers should make a greater effort to provide reasonably accurate statements regarding the burning time of their pyrotechnic grenades.

Functioning. None of the pyrotechnic grenades failed to function, but 17 out of 144 (12%) of the units tested functioned improperly. Eleven of the malfunctions resulted in the grenade "flaming", a condition in which fire instead of smoke is ejected from the exit ports. The flame typically burns with great intensity, often extending out for distances up to 12 inches from the grenade.

Five of the 24 Federal Triple Chaser grenades failed to separate completely into three sections in the normal manner, although this malfunction did not interfere with the normal burning of at least two of the sections. One of the Brunswick Skitter grenades was projected about 50 yards through the air after release, apparently as the result of a clogged or partially blocked exit port.

Temperature. The heat generated by burning grenades is of interest from two points of view. First, if the grenade remains cool enough to handle and also functions for any length of time, it can easily be picked up and thrown back at police or away from the target area. Secondly, grenades that emit flame during functioning present a potential fire hazard when used where combustible materials are present.

In order to determine how long grenades could be held after ignition, they were approached from upwind and picked up both with gloves and with bare hands. The most difficult grenade to handle was the Federal Spedeheat, which has exit ports on all surfaces and heats up rapidly as a result of the geometry of the burning mixture. Personnel highly motivated, or whose hands were protected with heavy insulation, could probably handle grenades for periods substantially exceeding the times reflected in Figure 1. Because it burns quickly and remains in motion, the Brunswick Skitter grenade is difficult to pick up while functioning and return is unlikely. The Federal Triple Chaser discourages return by the violent nature of its separation, although once separated the individual sections can be returned in the same manner as other burning grenades.

As a measure of their tendency to start fires, six of each of the grenades were discharged in a container of shredded newspaper. Those grenades that, as a result of their normal functioning, caused the newspaper to burn three or more times were rated "probable" in terms of fire potential. Those grenades that, as a result of their normal functioning, ignited the paper less than 3 out of 6 times were rated "possible" and those grenades that failed to ignite the paper, or did so only when malfunctioning, were rated "unlikely" to start fires. It should be stressed, however, that any pyrotechnic grenade can cause fires – none are completely fireproof!

	GRENADE	Specified Load Weight (grams) Agent	Specified Load Weight (grams) Other	Specified Burning Time (seconds)	Actual Burning Time (seconds) Average	Actual Burning Time (seconds) Range	Failed to Function	Functioned Improperly Number	Functioned Improperly %	Time Hand Held After Ignition (seconds) With Glove	Bare Hand Average	Bare Hand Range	Fire Potential in Combustible Material	Catalog Price (Jan. 69)
STANDARD	Federal Spedeheat	104	276	25-35	71.95	60-90	0	0	0%	20	14.5	12-16	Probable	$11.30
STANDARD	Lake Erie Continuous Discharge	106	179	25-30	152	137-170	0	5 flame	21%	40	22.15	15-27	Probable	$11.30
STANDARD	Penguin CN/Smoke	69	161	40	40	30-53	0	2 flame	8%	Total burning time	16.25	15-20	Probable	$ 9.95
MULTIPLE	Federal Triple Chaser	72	193	25-35	103.72	60-157	0	3 flame 5 incomplete separation	33%	NOT EVALUATED			Probable	$13.75
MINIATURE	Brunswick Skitter Grenade	16	22	10-20	12.86	11-18	0	1 flame 1 flight	9%	NOT EVALUATED			Unlikely	$ 3.50
MINIATURE	Federal 109 Pocket Grenade	20	30	16	19.27	16-21	0	0	0%	Total burning time	17.8	15-20	Probable	$ 3.75

FIGURE 1 – Summary of Selected Performance Characteristics of Pyrotechnic Grenades (See text for explanation)

EXPULSION GRENADES

Expulsion grenades are munitions that employ an explosive force to eject micropulverized agent into the air. This is accomplished either by rupturing or disintegrating the container or by forcing the agent out through exit ports.

Grenades that rupture or disintegrate present some risk of injury when they are discharged near the heads of unprotected personnel. They do release most of their agent loading, but when they explode on the ground a large percent of the agent is "dumped", resulting in a substantial loss in effective airborne concentration.

Those expulsion grenades that do not rupture or disintegrate present less potential for injury, but generally expel less of their loading because of their more complex internal design. An exception is the AAI Multi-Purpose grenade, which releases a high percent of its agent loading.

In this series of evaluations seven expulsion grenades were examined for functioning and fire potential. In addition, three of the grenades that do not rupture or disintegrate were checked for weight loss after release. (Figure 2)

Functioning. Only one of the 168 expulsion grenades failed to function. One Penguin Baseball grenade blew the burster and fuze assembly clear of the grenade body without releasing the agent. One AAI Multi-Purpose grenade malfunctioned as the result of a defective spin weld where the base attaches to the grenade body.

Fire Potential. Although it has been widely assumed that expulsion grenades could be used without risk of fire, it was found during this evaluation that several of the expulsion grenades are capable of igniting combustible material during normal functioning.

Weight Loss. As a general index to efficiency in the release of their micropulverized agent payload, 72 grenades were weighed before and after release with adjustment made for the weight of firing pins, safety levers, and other separating parts. While not exact (since the weight of the expended fuze and expulsion components is also lost) the results suggest that the Lake Erie Mob Master and Model 34 release up to about half of their specified loading and that the AAI Multi-Purpose grenade releases almost all of its agent content. The apparent performance differential between the Lake Erie and AAI systems is somewhat modified however by another characteristic.

When discharged on the ground, the AAI grenade evidences the same tendency to "dump" its payload as the rupturing or disintegrating grenades and, in fact, the manufacturer does not recommened the AAI grenade for any tactical use which would result in a ground release of the unit. On the other hand, the Lake Erie grenades evidence no tendency to "dump" their agent even during ground release. The average weight loss for both the Mob Master and the Model 34 did not vary significantly during air, rolling, or stationary releases.[1]

SUMMARY

The field evaluation of 312 chemical agent grenades resulted in the following conclusions regarding certain of their operating characteristics.

- Only 1 out of 312 grenades failed to function.
- 19 out of 311 grenades (6%) functioned improperly. Pyrotechnic grenades are the most likely to malfunction (8 to 1 in this evaluation).

[1] There was, of course, no way of determining what portion of the load became airborne and what portion, if any, was destroyed or decomposed in the expulsion process.

		GRENADE	Specified Average Load Weight (grams)	Weight Loss After Release (grams) Average	Weight Loss After Release (grams) Range	Average Weight Loss	Failed To Function Number	Failed To Function %	Functioned Improperly Number	Functioned Improperly %	Fire Potential In Combustible Material	Catalog Price (Jan. 69)
EXPELLED FROM EXIT PORT(S)	SINGLE	AAI Multi-Purpose Grenade	120	114.24	95.8-122.5	95.2%	0		Defective Spin Weld	4%	Unlikely	$15.00
		Lake Erie Mob Master	100	54.81	44.3-67.9	54.8%	0		0		Possible	$14.25
		Lake Erie Model 34	50	25.21	16.7-31.4	50.4%	0		0		Possible	$11.30
	MULTIPLE	Lake Erie Jumper Repeater	70	NOT EVALUATED			0		0		Unlikely	$13.75
RUPTURE/DISINTEGRATION	SINGLE	Federal Blast Dispersion	220	NOT EVALUATED			0		0		Unlikely	$11.30
		Federal Disintegrating	220	NOT EVALUATED			1	4%	0		Unlikely	$11.30
		Penguin Baseball Grenade	40	NOT EVALUATED			0		1 Fuze-Body Separation	4%	Possible	$10.95

FIGURE 2 – Summary of Selected Performance Characteristics of Expulsion Grenades (See text for explanation)

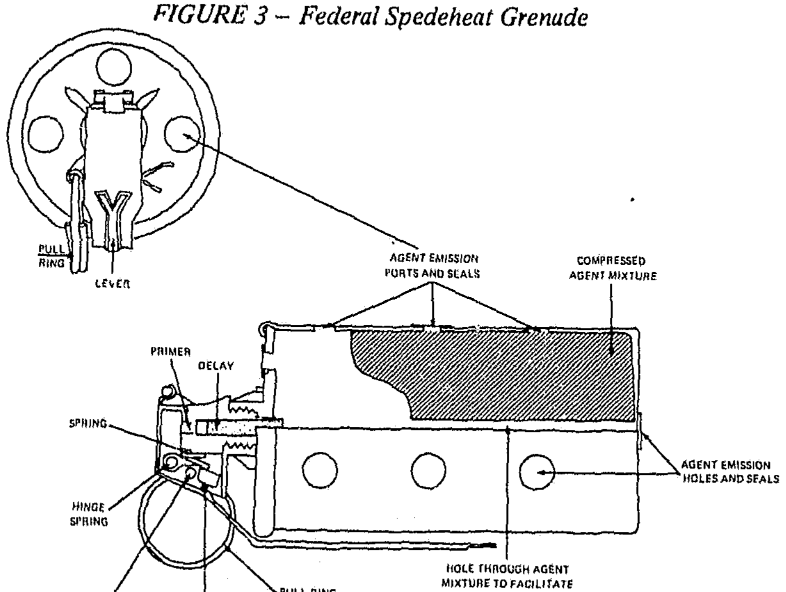
- There is substantial risk of fire with almost ali pyrotechnic and some expulsion grenades.
- The specified burning times for several standard pyrotechnic grenades are extremely inaccurate and should be adjusted.
- Pyrotechnic grenades can be handled for a sufficient period of time after ignition to permit their return or diversion by target personnel.
- Expulsion grenades that disintegrate or rupture lose most of their effectiveness when exploded on the ground.
- Expulsion grenades that expel agent from exit ports vary in efficiency. The AAI grenades deliver almost all of their payload while it is estimated that the Lake Erie Instantaneous Discharge munitions expel only about 50%. This differential is significant, however, only in air releases. Ground releases do not appear to affect the efficiency of the Lake Erie grenades, but under similar conditions the AAI grenade is sharply limited in its ability to develop an effective airborne concentration.

GENERAL OBSERVATIONS

In addition to the specific evaluation of those grenade characteristics that have already been discussed, other data were noted and are summarized in this section for the convenience of those who have not had an opportunity to observe the functioning of some or all of the munitions included in this evaluation.

STANDARD PYROTECHNIC GRENADES

FIGURE 3 – Federal Spedeheat Grenade



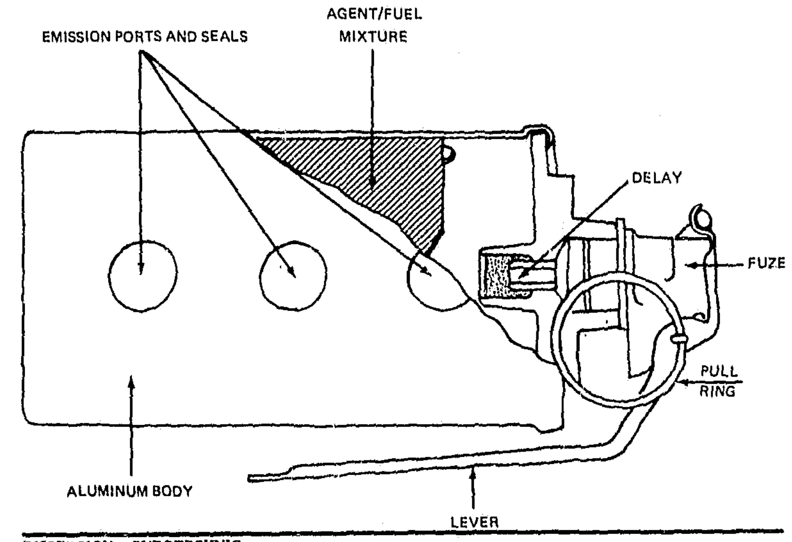
DISPERSION – PYROTECHNIC

	CN LOAD	CS LOAD
FILLER WEIGHT	370 grams	380 grams
ACTIVE AGENT	124 grams	104 grams
OTHER	246 grams	276 grams

FUZE DELAY	1 second	SHOTGUN LAUNCH	Yes
HEIGHT	6-1/4 inches with fuze	DIAMETER	2-5/8 inches at base
CONTAINER BODY MATERIAL	Aluminum		

Federal Spedeheat. The Federal Spedeheat grenade (Figure 3) is a time tested pyrotechnic munition with design features that make it very difficult to handle while it is functioning. Exit ports are located on all surfaces of the grenade body and combustion is vigorous. It functioned very reliably during this evaluation. Fuze timing was dependable, but burning time averaged 71.95 seconds, a considerable increase over the specified 25 to 35 seconds.

FIGURE 4 – Lake Erie Continuous Discharge Grenade



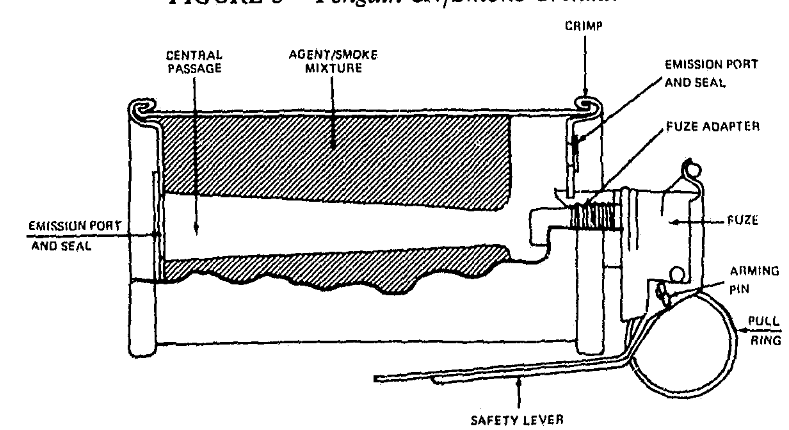
DISPERSION – PYROTECHNIC

	CN LOAD	CS LOAD
FILLER WEIGHT	306 grams	285 grams
ACTIVE AGENT	128 grams	106 grams
OTHER	178 grams	179 grams

FUZE DELAY	2 seconds	SHOTGUN LAUNCH	Yes
HEIGHT	6-1/2 inches with fuze	DIAMETER	2-5/8 inches at base
CONTAINER BODY MATERIAL	Aluminum		

Lake Erie Continuous Discharge. This grenade (Figure 4) has exit ports on all but the base surface and burning of the payload is slower than with the Spedeheat unit. This grenade burns a 285 gram payload in an average of 152 seconds as contrasted with a burning time of 71.95 seconds for the 380 gram payload of the Spedeheat. It is interesting to note, however, that both grenades contain about the same amount of agent. Fuze timing was reliable and all tested units functioned, although the number of "flame" defects was the highest recorded for the three standard pyrotechnic grenades.

FIGURE 5 – Penguin CN/Smoke Grenade



DISPERSION — PYROTECHNIC

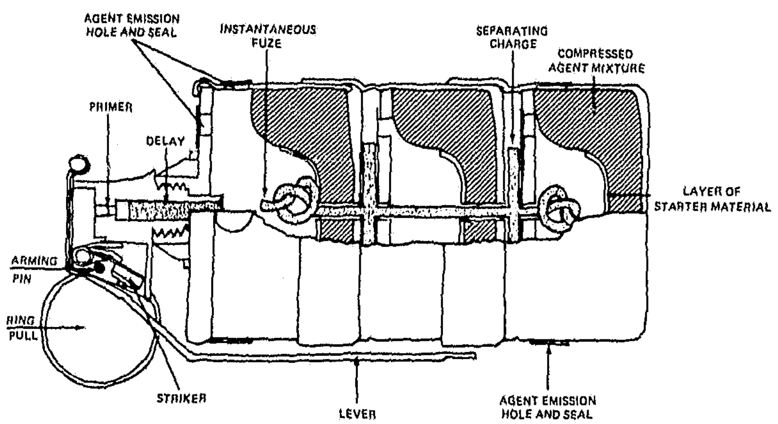
	CN LOAD	CS LOAD
FILLER WEIGHT	230 grams	
ACTIVE AGENT	69 grams	
OTHER	161 grams	

FUZE DELAY	4 seconds	SHOTGUN LAUNCH	Yes
HEIGHT	5-3/4 inches	DIAMETER	2-1/2 inches
CONTAINER BODY MATERIAL	Steel		

Penguin CN/Smoke. The Penguin grenade (Figure 5) burned for the specified period of 40 seconds. With exit ports in the top and base only, this unit was the easiest to handle. In fact, if the paraffin into which the grenade is dipped during manufacture did not heat up, it would probably be possible to handle this unit with bare hands for an even longer period of time. Although all three of the standard pyrotechnic grenades present a substantial risk of fire when used near combustible materials, only the Penguin unit contains a warning to this effect on the label.

MULTIPLE PYROTECHNIC GRENADE

FIGURE 6 – Federal Triple Chaser Grenade



DISPERSION — PYROTECHNIC

	CN LOAD	CS LOAD
FILLER WEIGHT	290 grams	265 grams
ACTIVE AGENT	92 grams	72 grams
OTHER	198 grams	193 grams

FUZE DELAY 2 seconds
HEIGHT 6-1/4 inches with fuze
CONTAINER BODY MATERIAL Aluminum
SHOTGUN LAUNCH Not Recommended
DIAMETER 2-5/8 inches at base

Federal Triple Chaser. This grenade (Figure 6) separates upon ignition into three sections which then burn in the normal manner. The separation is violent and usually accompanied by a visible flash. Each section travels in an unpredictable direction, occasionally ranging up to thirty or forty yards with a total separation distance of up to sixty or seventy yards. Although air bursts usually resulted in the greatest separation distance, even this was not absolutely consistent.

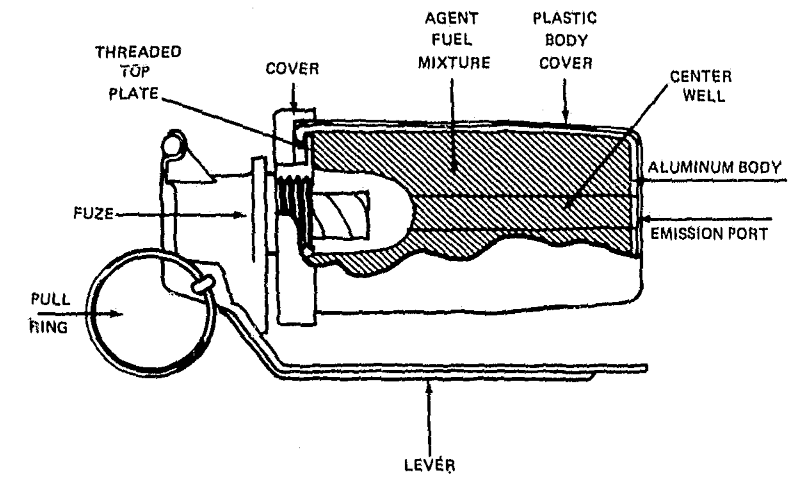
As indicated in the following table, the bottom or base section tended to burn for the longest period of time.

SAMPLE	RELEASE	BURNING TIME (MINUTES/SECONDS) TOP (FUZE)	CENTER	BOTTOM (BASE)
1	Air	2.00	1.05	1.12
2	Air	0	1.15	1.25
3	Air	0.55	1.10	2.00
4	Air	0.15	0.55	2.00
5	Air	1.05	1.00	1.25
6	Air	0.50	1.15	1.52
7	Ground	.50	1.00	1.00
8	Ground	.45	0.55	1.25
9	Ground	.25	1.25	2.00
10	Ground	20	0.55	2.00
11	Ground	.25	1.30	1.50
12	Ground	.28	1.15	0.50

Three of the Triple Chasers "flamed" and five did not separate completely. The failure to separate did not seem to prevent at least one of the attached sections from burning normally. Again, the burning period greatly exceeded the specified period. The violent separation, unpredictable behavior, and relatively low agent loading of the Triple Chaser would suggest that for most situations this grenade should be regarded as a special supplement rather than as a substitute for the standard pyrotechnic munitions.

MINIATURE PYROTECHNIC GRENADES

FIGURE 7 – Brunswick Skitter Grenade



DISPERSION — PYROTECHNIC

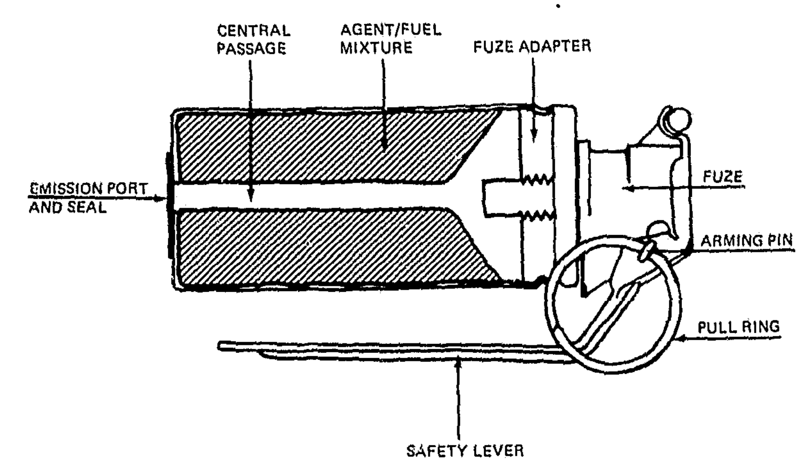
	CN LOAD	CS LOAD
FILLER WEIGHT	38 grams	38 grams
ACTIVE AGENT	16 grams	16 grams
OTHER	22 grams	22 grams

FUZE DELAY 1-1/2 seconds
HEIGHT 4 inches with fuze
CONTAINER BODY MATERIAL Plastic Covered Aluminum
SHOTGUN LAUNCH Not Recommended
DIAMETER 1-3/8 inches

Brunswick Skitter. This grenade (Figure 7), one of two low-volume units evaluated, performed well and was considered the most unlikely of all the pyrotechnic grenades to start fires in combustible materials. When thrown onto a reasonably smooth surface the Skitter grenade usually remains in motion during a large portion of the burning time. The scooting or spinning action is produced by the rush of agent/smoke mixture from a single, off-center exit port on the base of the grenade. The motion and rapid emission make it unlikely that this unit will be picked up during functioning, but, although this feature was not evaluated, the Skitter grenade probably remains cool enough to handle without gloves.

Both Skitter grenade malfunctions apparently were the result of the plastic outer cover failing to rupture completely over the exit port. In one case, this resulted in the burning of the plastic cover. This grenade did not "flame" in the usual manner, but simply burned its outer protective cover. The second malfunction resulted in the grenade traveling airborne for about 50 yards from the release point. In both cases, the grenades burned and discharged their fuel/agent mixture.

FIGURE 8 – Federal Pocket Grenade



DISPERSION — PYROTECHNIC

	CN LOAD	CS LOAD
FILLER WEIGHT	50 grams	50 grams
ACTIVE AGENT	20 grams	20 grams
OTHER	30 grams	30 grams

FUZE DELAY 1-1/2 seconds
HEIGHT 4-1/8 inches
CONTAINER BODY MATERIAL Aluminum
SHOTGUN LAUNCH Not Recommended
DIAMETER 1-3/8 inches

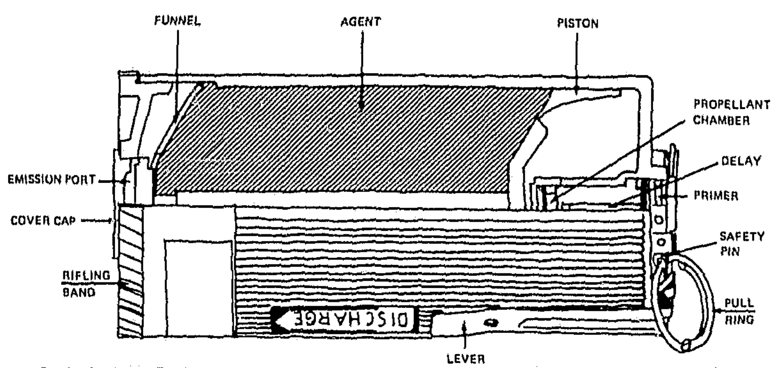
Federal Pocket. This grenade (Figure 8), the second of the two miniature units evaluated, performed well in all aspects observed. There were no failures or malfunctions and the burning time was well within the period specified by the manufacturer. This grenade, like the Skitter grenade, burns rapidly and the agent/smoke is released from an exit port in the base of the grenade. Because the exit port is larger and is centered, the Pocket grenade does not normally move about during functioning.

Although the Pocket grenades were otherwise impressive, they did frequently emit a shower of sparks or flame when discharged and this characteristic undoubtedly was responsible for their tendency to start fires in combustible materials.

STANDARD EXPULSION GRENADES

All of the expulsion grenades functioned well during this evaluation and most of their essential characteristics were discussed earlier.

FIGURE 9 – AAI Multi-Purpose Grenade



DISPERSION — EXPULSION

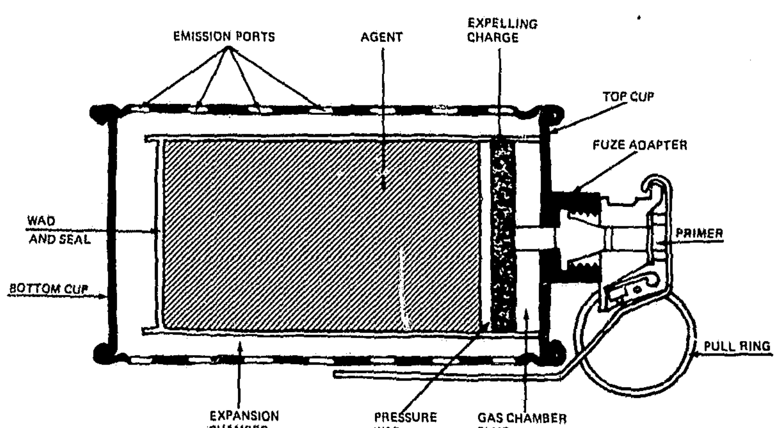
	CN LOAD	CS LOAD
FILLER WEIGHT	140 grams	120 grams
ACTIVE AGENT	95 grams	114 grams
OTHER	45 grams	6 grams

FUZE DELAY	Adjustable delay 2 or 5 seconds	SHOTGUN LAUNCH	Yes
HEIGHT	6-1/2 inches	DIAMETER	3-1/4 inches
CONTAINER BODY MATERIAL	Plastic		

AAI Multi-Purpose. This grenade (Figure 9) was designed expressly for use by civilian police agencies and its design incorporates several features not generally found in traditional munitions. It has, for example, a selector that allows for either a 2 second or a 5 second fuze delay period. It can be hand held and directed during release and it will not start fires in combustible material during normal functioning.

Although the Multi-Purpose grenade is not, as discussed previously, effective in ground discharges, it delivers an impressive 95.2% weight loss during functioning and appeared, during this evaluation, to be one of the units least likely to cause personnel injury or fires.

FIGURE 10 – Lake Erie Mob Master



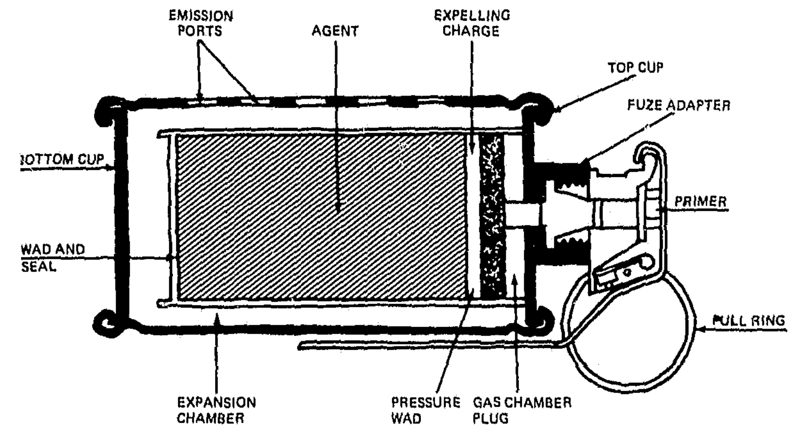
DISPERSION — EXPULSION

	CN LOAD	CS LOAD
FILLER WEIGHT	125 grams	100 grams
ACTIVE AGENT	106 grams	85 grams
OTHER	19 grams	15 grams

FUZE DELAY	1-3/4 seconds	SHOTGUN LAUNCH	Not Recommended
HEIGHT	6-3/4 inches	DIAMETER	3 inches at base
CONTAINER BODY MATERIAL	Steel		

Lake Erie Mob Master and Model 34. These grenades (Figure 10 and 11) employ the same design features and differ only in size and payload. The Mob Master has a reported average loading of 100 grams as compared with a 50 gram loading for the Model 34. Both units employ an internal container that houses the micropulverized agent and an explosive charge. Upon detonation, the agent is blown out through the base of the internal container, into the space between the two containers, and ultimately out of exit ports in the external body wall.

FIGURE 11 – Lake Erie Model 34 Instantaneous Discharge Grenade



DISPERSION — EXPULSION

	CN LOAD	CS LOAD
FILLER WEIGHT	70 grams	50 grams
ACTIVE AGENT	60 grams	43 grams
OTHER	10 grams	7 grams

FUZE DELAY	1-3/4 seconds	SHOTGUN LAUNCH	Not Recommended*
HEIGHT	6-1/4 inches	DIAMETER	2-3/8 inches at base
CONTAINER BODY MATERIAL	Steel		

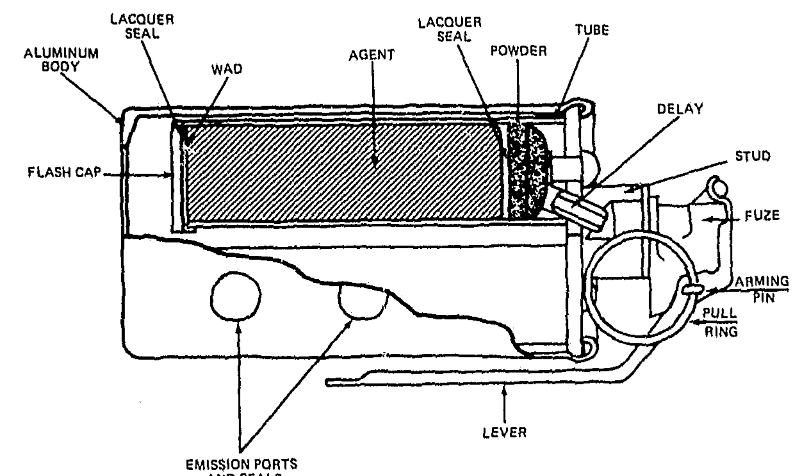
*This grenade can be fired from an AR-15 rifle by means of a special launching fin supplied by Lake Erie Chemical Company.

While this complex design avoids the fragmentation, concussion, and "dumping" characteristics of most expulsion grenades, it does result in the loss of about half of the reported payload. Even so, these grenades and their cousin the Jumper Repeater, are the only expulsion grenades that appear to function with any degree of efficiency during ground release.

For some unknown reason, perhaps the use of black powder in the expulsion charge, both grenades started fires in combustible material during this evaluation.

MULTIPLE DISCHARGE EXPULSION GRENADES

FIGURE 12 – Lake Erie Jumper Repeater Grenade



DISPERSION — EXPULSION

	CN LOAD	CS LOAD
FILLER WEIGHT	82 grams	70 grams
ACTIVE AGENT	70 grams	60 grams
OTHER	12 grams	10 grams

FUZE DELAY	2 seconds	SHOTGUN LAUNCH	Not Recommended
HEIGHT	6-1/2 inches with fuze	DIAMETER	2-5/8 inches at base
CONTAINER BODY MATERIAL	Steel		

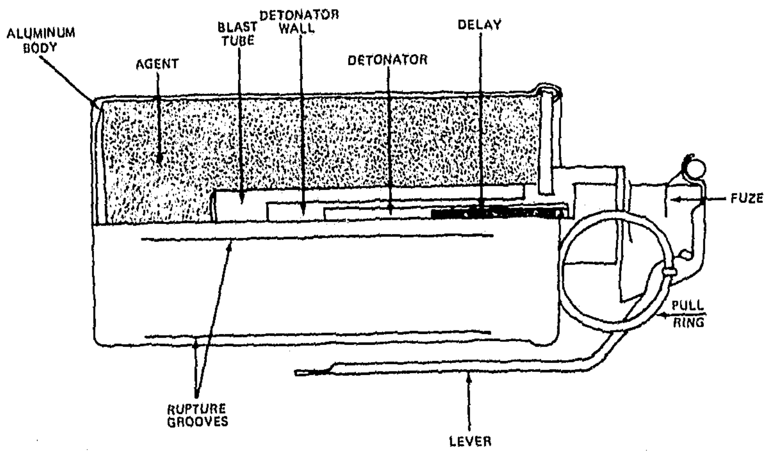
Lake Erie Jumper Repeater. This grenade (Figure 12) employs the same design features as the Mob Master and Model 34, except that it contains 3 separate internal tubes that discharge at about one second intervals. In this way the release of agent is spread in three bursts over an area of up to about ten feet from the point of release, although the direction of movement during discharge is unpredictable.

From the standpoint of cost effectiveness, it is difficult to understand why the Jumper Repeater would be employed instead of the Mob Master or even the Model 34. This is especially true since the return or diversion of expulsion munitions is seldom a problem and the area coverage achieved by the Jumper Repeater is not substantially greater.

Like the Mob Master and the Model 34, the Jumper Repeater grenade employs a steel body in order to adequately contain the internal explosion. Consequently, all three provide heavy missiles that can be thrown back at police after the grenade has functioned.

RUPTURE/DISINTEGRATING EXPULSION GRENADES

FIGURE 13 – Federal Blast Dispersion Grenade



DISPERSION — EXPULSION

	CN LOAD	CS LOAD
FILLER WEIGHT	220 grams	220 grams
ACTIVE AGENT	153 grams	152 grams
OTHER	67 grams	68 grams

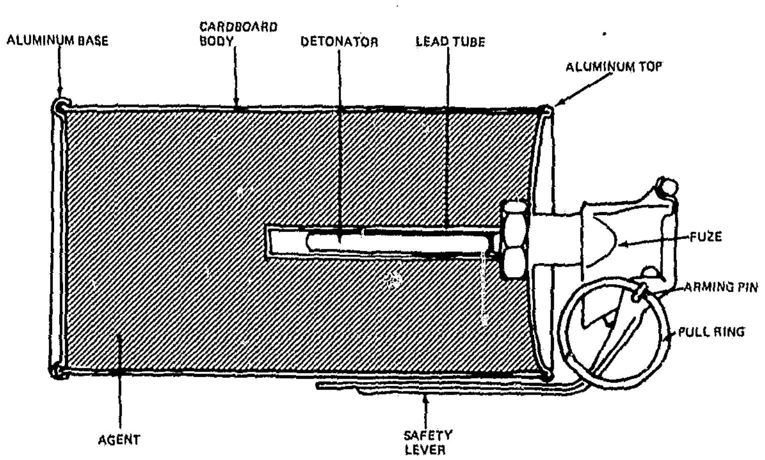
FUZE DELAY	2 seconds	SHOTGUN LAUNCH	Not Recommended
HEIGHT	6-1/4 inches	DIAMETER	2-5/8 inches at base
CONTAINER BODY MATERIAL	Aluminum		

Federal Blast Dispersion and Disintegrating Grenades. The only major difference between these grenades (Figures 13 and 14) is that the former employs an aluminum container and the latter a fiber body. In functioning, the Blast Dispersion grenade ruptures open along pre-formed grooves in the body and the Disintegrating unit blows the container into small pieces.

Both grenades expel their entire payload during air bursts, but tend to "dump" badly during ground releases. Since these munitions carry by far the largest payloads in the expulsion grenade class, they can be effectively employed whenever fragmentation or concussion risks can be avoided.

The velocity of parts separating from these grenades is unknown, but during this evaluation six of each grenade were detonated on the ground within two to three feet of exposed personnel without injury of any sort resulting. Unfortunately, in the case of the Blast Dispersion grenade, the aluminum body did not impact on personnel and its injury potential remains unknown. However, from general observation of the flight of the lightweight aluminum body, it would appear that injury from a ground or air burst is unlikely unless the detonation takes place very close to exposed skin or the eyes are struck directly by fragments from a nearby release.

FIGURE 14 – Federal Disintegrating Grenade

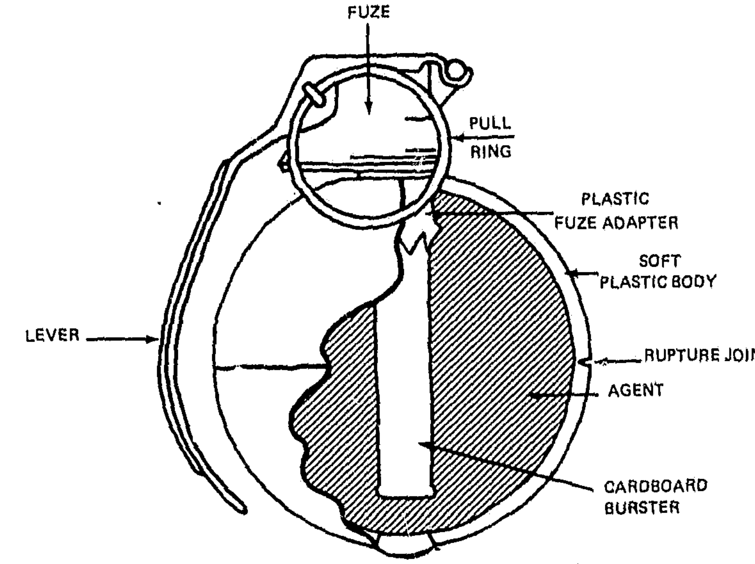


DISPERSION — EXPULSION

	CN LOAD	CS LOAD
FILLER WEIGHT	220 grams	220 grams
ACTIVE AGENT	153 grams	150 grams
OTHER	67 grams	70 grams

FUZE DELAY	2 seconds	SHOTGUN LAUNCH	Not Recommended
HEIGHT	6-1/2 inches	DIAMETER	2-3/4 inches at base
CONTAINER BODY MATERIAL	Cardboard		

FIGURE 15 – Penguin Baseball Grenade



DISPERSION — EXPULSION

	CN LOAD	CS LOAD
FILLER WEIGHT	40 grams	40 grams
ACTIVE AGENT	20 grams	20 grams
OTHER	20 grams	20 grams

FUZE DELAY	4 seconds	SHOTGUN LAUNCH	Not Recommended
HEIGHT	4 inches	DIAMETER	2-7/8 inches
CONTAINER BODY MATERIAL	Plastic		

Penguin Baseball. The Penguin Baseball grenade (Figure 15) employs a cardboard burster to separate a round plastic body and releases about 40 grams of a 50% CS mixture (CS/X5). The separation is violent, frequently flinging the plastic hemispheres up to 30 or 40 yards, and is often accompanied by a visible flash at the moment of discharge. Like other grenades in its class, the Baseball "dumps" badly during ground release, but the violence and noise of the detonation may, in themselves, assist in scattering target personnel.

The weight and shape of the Baseball permit it to be thrown with considerable accuracy and the fuzing is reliable enough to allow air bursts to be achieved consistently with only a minimal amount of practice.

This grenade was one of the expulsion grenades that started fires in combustible materials during this evaluation series.

APPENDIX C

Chemical Munition Data Sheets

INTRODUCTION

This section contains data sheets covering most of the chemical munitions available to U. S. law enforcement agencies. With the exception of the data on military devices, all information was obtained from the manufacturer. While it is believed that this information is generally accurate, it has not been verified independently by the IACP.[1] The symbol "NR" has been used to designate information that manufacturers are unable or unwilling to supply.

Drawings used to illustrate the various products are for the purpose of identification and nomenclature only. They are not drawn to scale and do not necessarily include every design feature.

AAI Corporation
York Road
Cockeysville, Maryland 21030
Phone: (301) 666-1400

B&H Enterprises, Inc.
P. O. Box 709
Leesburg, Florida 32748
Phone: (904) 787-5897

Brunswick Corporation
Technical Products Division
69 West Washington Street
Chicago, Illinois 60602
Phone: (312) 341-7000

Federal Laboratories, Inc.
Saltsburg, Pennsylvania 15681
Phone: (412) 635-2501

General Ordnance Equipment Corporation
P. O. Box 11211, Freeport Road
Pittsburgh, Pennsylvania 15238
Phone: (412) 782-2161

Lake Erie Chemical Company
P. O. Box 208
Rock Creek, Ohio 44084
Phone: (216) 563-3681

Middle West Marketing Company
216-226 South Hoyne Avenue
Chicago, Illinois 60612
Phone: (312) 421-2339

Northrop Carolina, Inc.
P. O. Box 3049
Asheville, North Carolina 28802
Phone: (704) 298-7941

P. M. Tabor Company
2083 Laguna Canyon Road
Laguna Beach, California 92651
Phone: (714) 494-8989

Penguin Industries, Inc.
P. O. Box 97
Parkesburg, Pennsylvania 19365
Phone: (215) 384-6000

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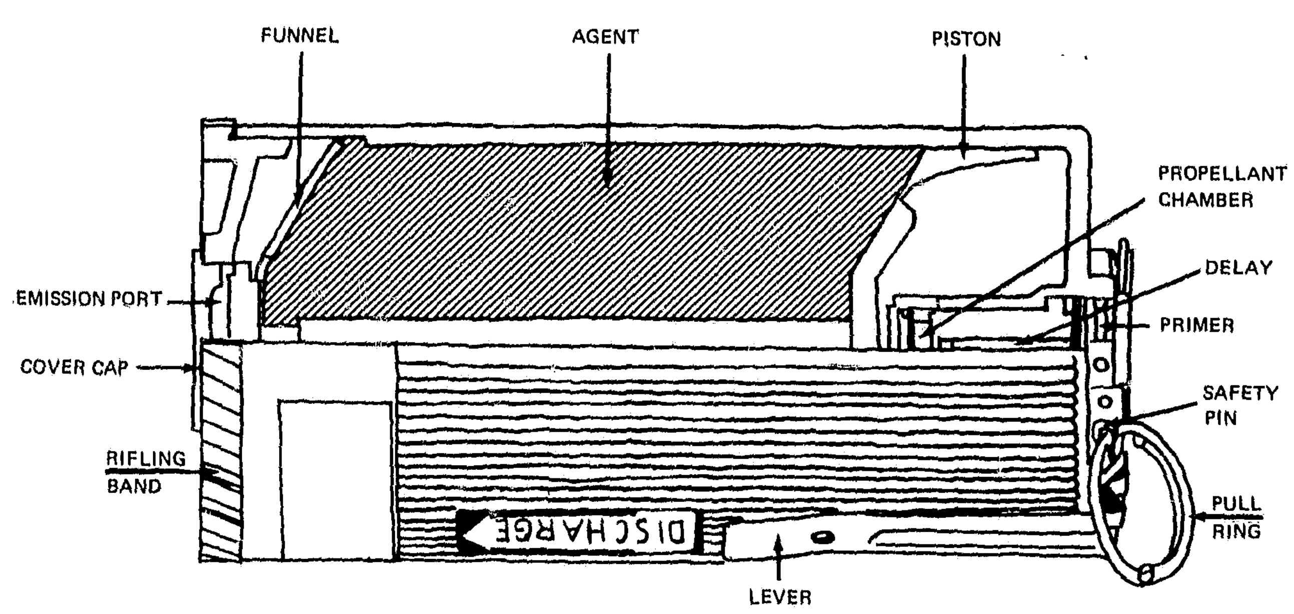
[1]For results of field evaluation of chemical agent grenades, see Appendix B.

CHEMICAL MUNITION DATA SHEETS

CONTENTS

GRENADE, EXPULSION



AAI MULTI-PURPOSE GRENADE

DISPERSION EXPULSION

	CN	CS
TOTAL WEIGHT	16 ounces	16 ounces
FILLER WEIGHT	140 grams	120 grams
ACTIVE AGENT	95 grams	114 grams
OTHER	45 grams	6 grams
CATALOG NUMBER	MPG 100	MPG 120
CATALOG PRICE (1/69)	$13.50	$15.00
COLOR	Red Base	Blue Base

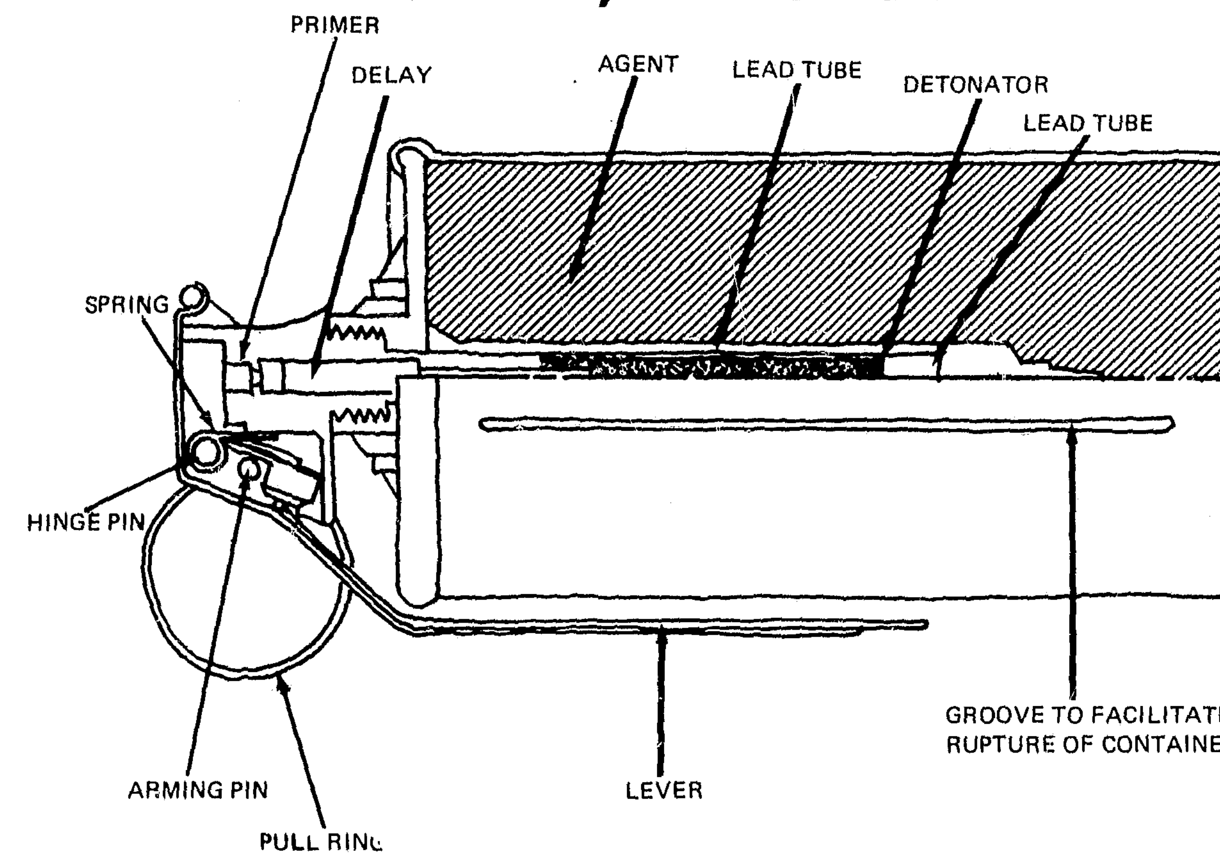
FUZE TIME Adjustable delay 2 *or* 5 seconds
AGENT EMISSION TIME Less than 1/10 second
SHOTGUN LAUNCH Yes

CONTAINER BODY MATERIAL Plastic
HEIGHT 6-1/2 inches
DIAMETER 3-1/4 inches

MANUFACTURER AAI Corporation

OPERATION Grasp the grenade in the throwing hand with the fingers holding the lever tight against the body of the grenade. Check fuze delay selector for proper setting. Pull out the arming pin by means of the pull ring. Do not relax grip on the lever before throwing. Throw. If grenade is to be hand held during discharge, grip firmly and release handle with body base pointed slightly upward in the desired direction of release. Whether hand held or thrown, release of the lever will allow the striker to fire the primer and after the selected delay the agent cloud will be discharged from the base of the grenade body. The plastic grenade body remains in one piece and there is no noticeable increase in temperature.

GRENADE, EXPULSION



FEDERAL BLAST DISPERSION GRENADE

DISPERSION EXPULSION

	CN	CS
TOTAL WEIGHT	15-1/2 ounces	15 ounces
FILLER WEIGHT	220 grams	220 grams
ACTIVE AGENT	153 grams	152 grams
OTHER	67 grams	68 grams
CATALOG NUMBER	121	514
CATALOG PRICE (1/69)	$11.30	$11.30
COLOR	Red	Blue

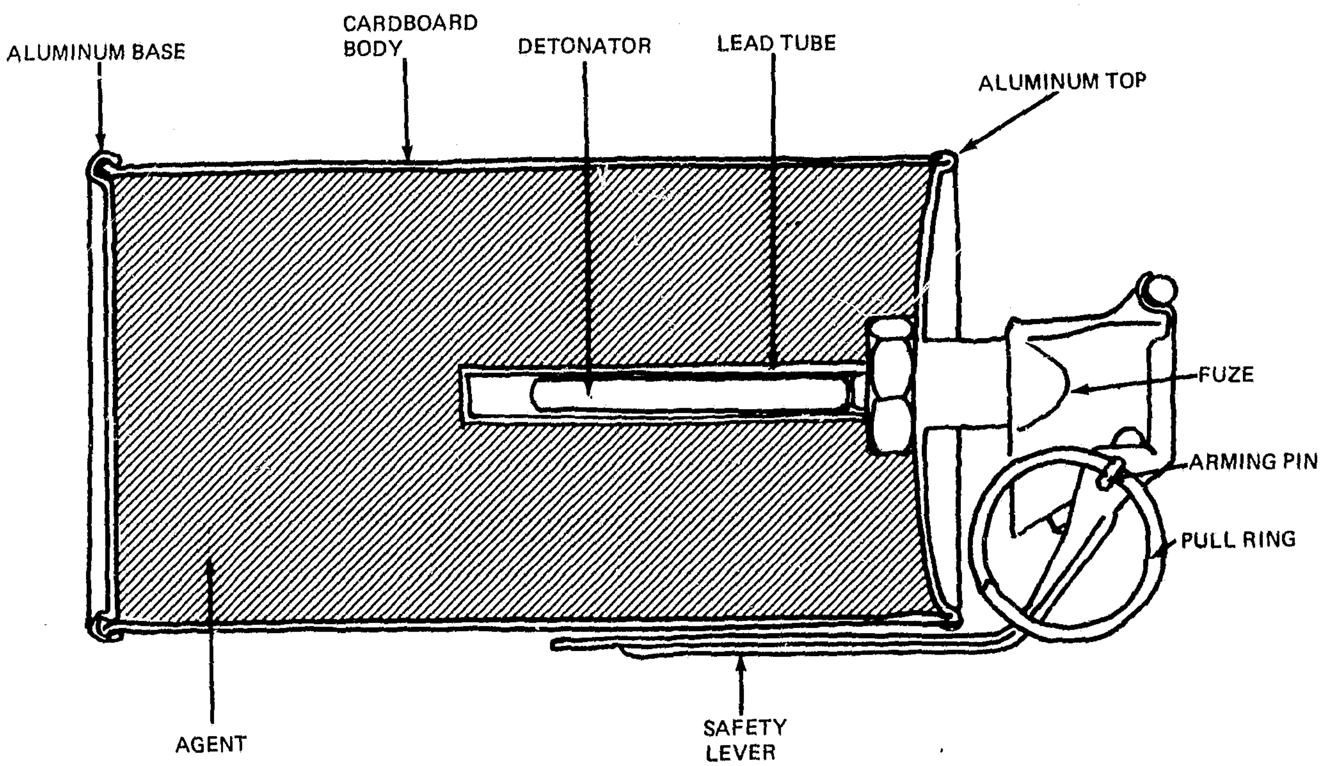
FUZE TIME 2 seconds
AGENT EMISSION TIME Instantaneous
SHOTGUN LAUNCH Not recommended

CONTAINER BODY MATERIAL Aluminum
HEIGHT 6-1/4 inches
DIAMETER 2-5/8 inches at base

MANUFACTURER Federal Laboratories, Inc.

OPERATION Grasp the grenade in the throwing hand with fingers holding the lever tight against the body of the grenade. Pull out the arming pin by means of the pull ring. Do not relax grip on the lever before throwing. Throw. The lever will fly off allowing the striker to fire the primer. Approximately two seconds later the fuze will ignite the detonator which will cause the grenade body to split along the rupture grooves and release a cloud of agent. The discharge is instantaneous. The metal body will remain in one piece, with only the fuse and top plate being thrown clear during the functioning of the grenade.

GRENADE, EXPULSION



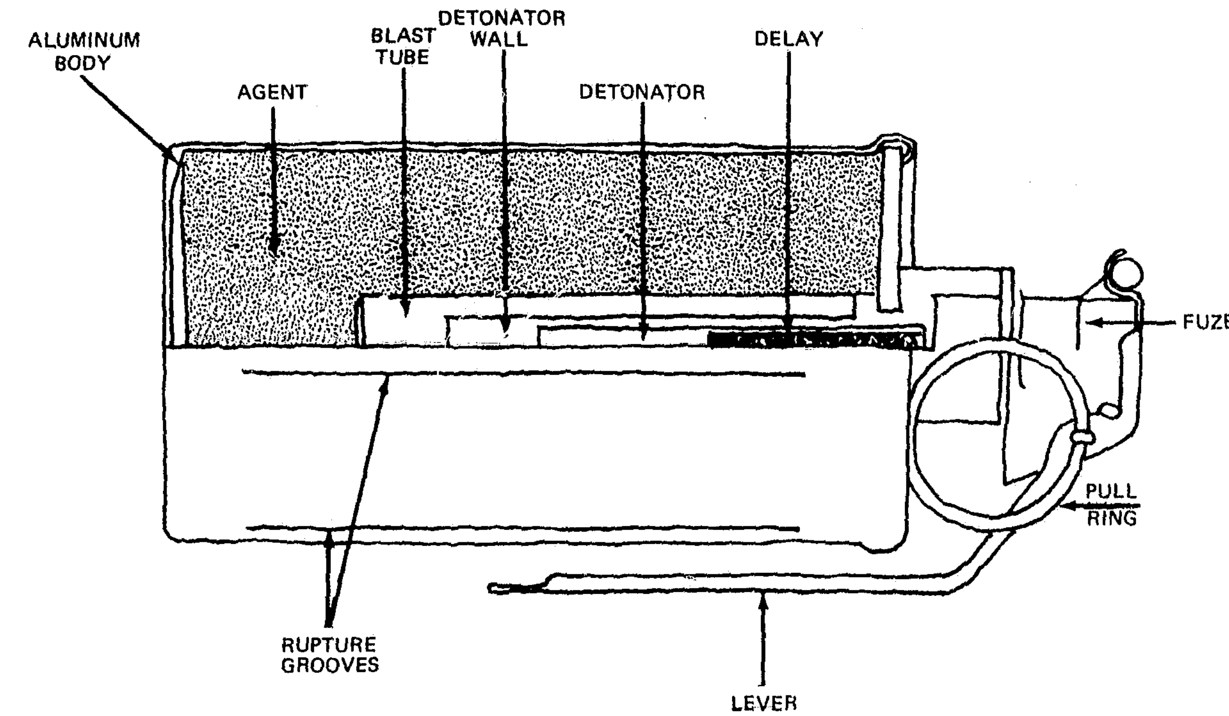
FEDERAL DISINTEGRATING GRENADE

	CN	CS
DISPERSION	EXPULSION	
TOTAL WEIGHT	13 ounçes	13 ounces
FILLER WEIGHT	220 grams	220 grams
ACTIVE AGENT	153 grams	150 grams
OTHER	67 grams	70 grams
CATALOG NUMBER	120	520
CATALOG PRICE (1/69)	$11.30	$11.30
COLOR	Red	Blue

FUZE TIME	2 seconds
AGENT EMISSION TIME	Instantaneous
SHOTGUN LAUNCH	Not recommended
CONTAINER BODY MATERIAL	Cardboard
HEIGHT	6-1/2 inches
DIAMETER	2-3/4 inches at base
MANUFACTURER	Federal Laboratories, Inc.

OPERATION Grasp the grenade in the throwing hand with the fingers holding the lever tight against the body of the grenade. Pull out the arming pin by means of the pull ring. Do not relax grip on the lever before throwing. Throw. The lever will fly off allowing the striker to fire the primer. Approximately two seconds later the fuze will ignite the detonator which will cause the cardboard body to disintegrate, releasing the agent cloud. The discharge is instantaneous.

GRENADE, EXPULSION



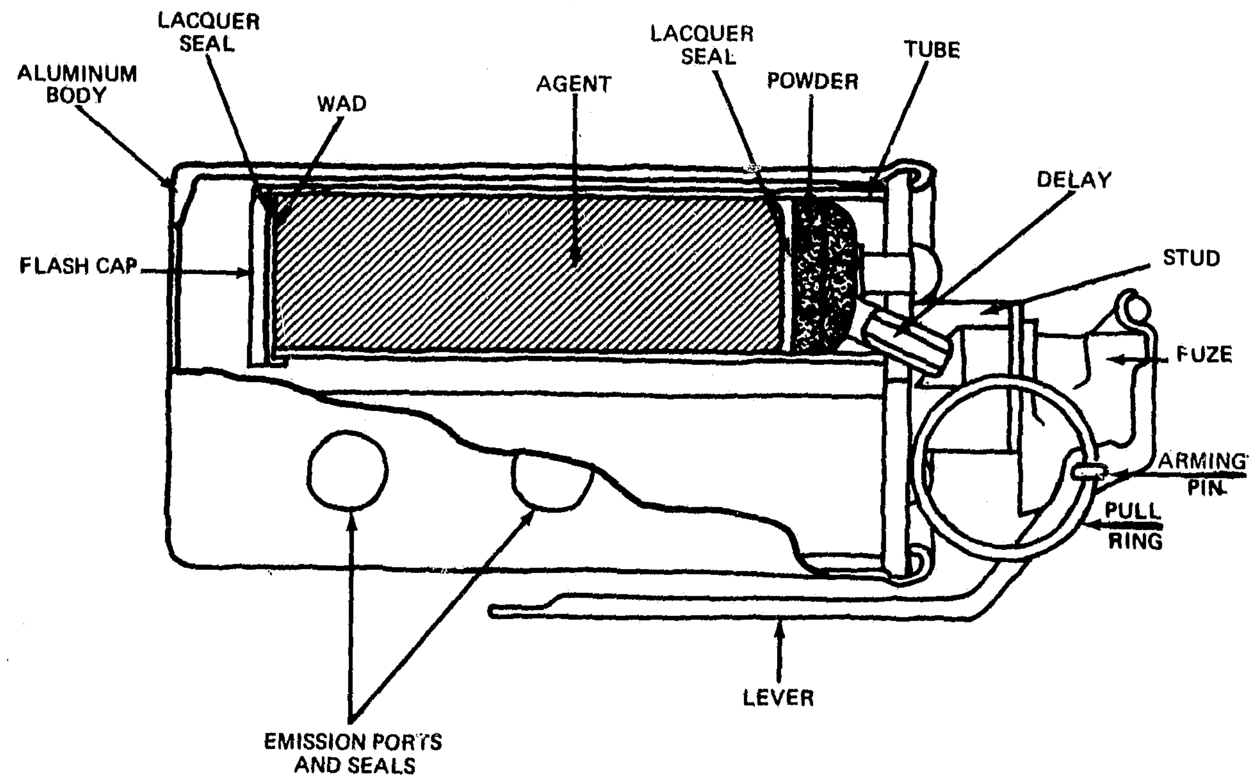
LAKE ERIE BLAST DISPERSION GRENADE (Discontinued)

	CN	CS
DISPERSION	EXPULSION	
TOTAL WEIGHT	16 ounces	15½ ounces
FILLER WEIGHT	NR grams	NR grams
ACTIVE AGENT	148 grams	135 grams
OTHER	NR grams	NR grams
CATALOG NUMBER	3CN	3CS
CATALOG PRICE (1/69)	Discontinued	Discontinued
COLOR	Red	Blue

FUZE TIME	2 seconds
AGENT EMISSION TIME	Instantaneous
SHOTGUN LAUNCH	Not Recommended
CONTAINER BODY MATERIAL	Aluminum
HEIGHT	6-1/2 inches with fuze
DIAMETER	2-5/8 inches at base
MANUFACTURER	The Lake Erie Chemical Company

OPERATION Grasp the grenade in the throwing hand with the fingers holding the lever against the body of the grenade. Pull out the arming pin by means of the pull ring. Do not relax grip on the lever before throwing. Throw. The lever will fly off allowing the striker to fire the primer. In approximately 2 seconds the fuze will ignite the detonator, causing the grenade body to split along grooves and release the agent cloud. There will be no fragmentation of the grenade body.
This grenade has been discontinued by the manufacturer and can no longer be purchased from the factory.

GRENADE, EXPULSION



LAKE ERIE JUMPER REPEATER GRENADE

		CN	CS
DISPERSION	EXPULSION		
TOTAL WEIGHT		24 ounces	24 ounces
FILLER WEIGHT		82 grams	70 grams
ACTIVE AGENT		70 grams	60 grams
OTHER		12 grams	10 grams
CATALOG NUMBER		1CN	1CS
CATALOG PRICE (1/69)		$13.75	$13.75
COLOR		Red	Blue

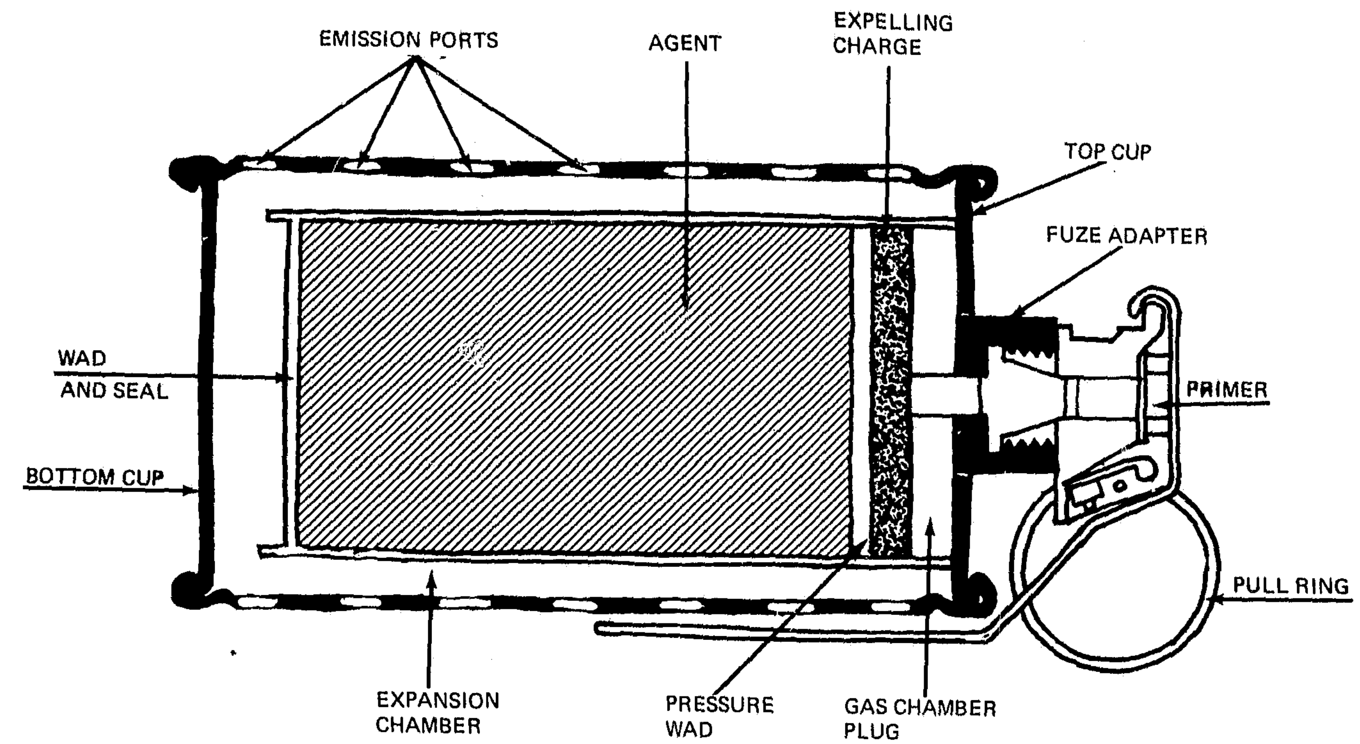
FUZE TIME 2 seconds
AGENT EMISSION TIME 3 instantaneous bursts within 4-3/4 seconds
SHOTGUN LAUNCH Not recommended

CONTAINER BODY MATERIAL Steel
HEIGHT 6-1/2 inches with fuze
DIAMETER 2-5/8 inches at base

MANUFACTURER The Lake Erie Chemical Company

OPERATION Grasp the grenade in the throwing hand with the fingers holding the lever against the body of the grenade. Pull out the arming pin by means of the pull ring. Do not relax grip on the lever before throwing. Throw. The lever will fly off allowing the striker to fire the primer. In approximately 2 seconds the fuze will ignite the first detonator, releasing the first agent cloud. As the grenade jumps from 5 to 15 feet on the ground, a second and third burst will be produced at one second intervals. There will be no fragmentation of the grenade body.

GRENADE, EXPULSION



LAKE ERIE MOB MASTER INSTANTANEOUS DISCHARGE GRENADE

		CN	CS
DISPERSION	EXPULSION		
TOTAL WEIGHT		34 ounces	34 ounces
FILLER WEIGHT		125 grams	100 grams
ACTIVE AGENT		106 grams	85 grams
OTHER		19 grams	15 grams
CATALOG NUMBER		7 CN	7 C S
CATALOG PRICE (1/69)		$14.25	$14.25
COLOR		Red	Blue

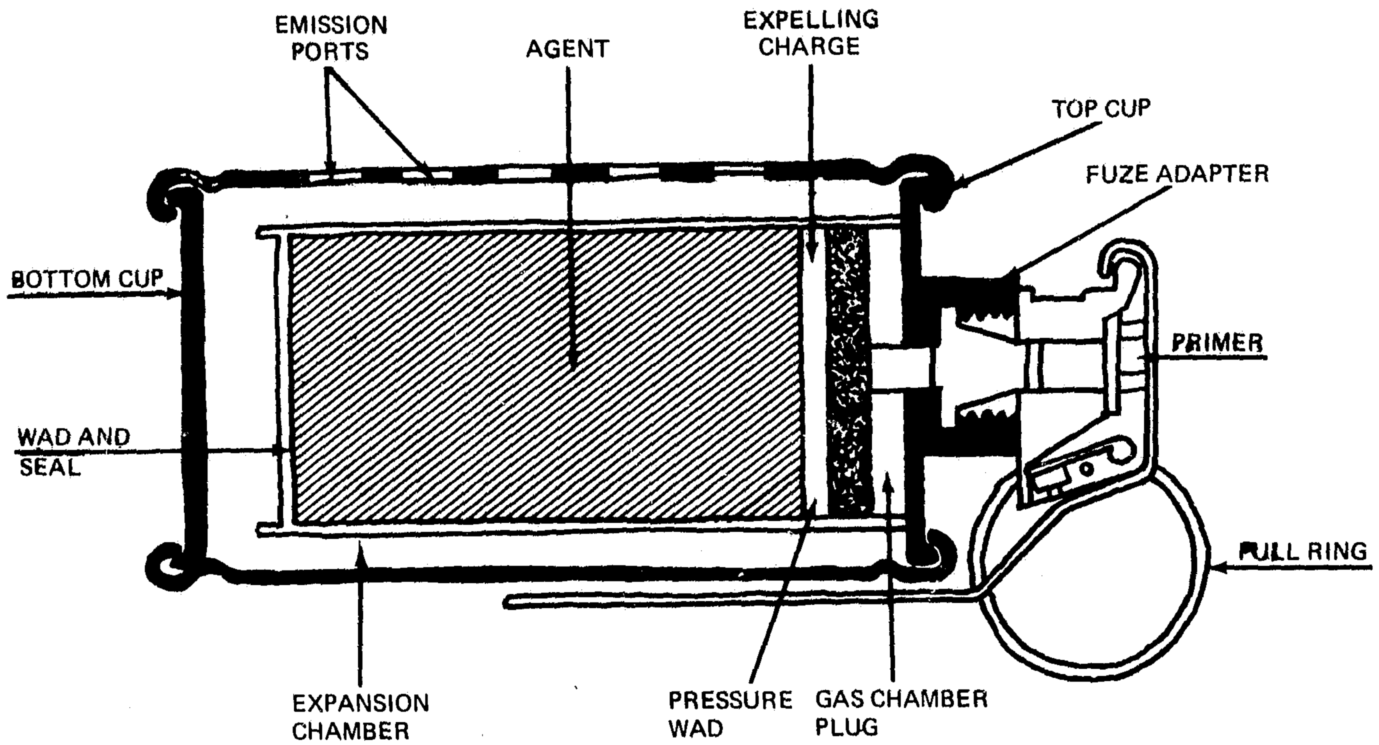
FUZE TIME 1-3/4 seconds
AGENT EMISSION TIME Instantaneous
SHOTGUN LAUNCH Not recommended

CONTAINER BODY MATERIAL Steel
HEIGHT 6-3/4 inches
DIAMETER 3 inches at base

MANUFACTURER Lake Erie Chemical Company

OPERATION Grasp the grenade in the throwing hand with the fingers holding the lever against the body of the grenade. Pull out the arming pin by means of the pull ring. Do not relax grip on the lever before throwing. Throw. The lever will fly off allowing the striker to fire the primer. In approximately 1-3/4 seconds the fuze will ignite the expelling charge, blasting the agent charge out of the base of its container into the expansion chamber and ultimately out of the expelling ports. There will be no fragmentation of the grenade body.

GRENADE, EXPULSION



LAKE ERIE MODEL 34 INSTANTANEOUS DISCHARGE GRENADE

DISPERSION EXPULSION

	CN	CS
TOTAL WEIGHT	20 ounces	19 ounces
FILLER WEIGHT	70 grams	50 grams
ACTIVE AGENT	60 grams	43 grams
OTHER	10 grams	7 grams
CATALOG NUMBER	4CN	4CS
CATALOG PRICE (1/69)	$11.30	$11.30
COLOR	Red	Blue

FUZE TIME 1-3/4 seconds
AGENT EMISSION TIME Instantaneous
SHOTGUN LAUNCH Not recommended*

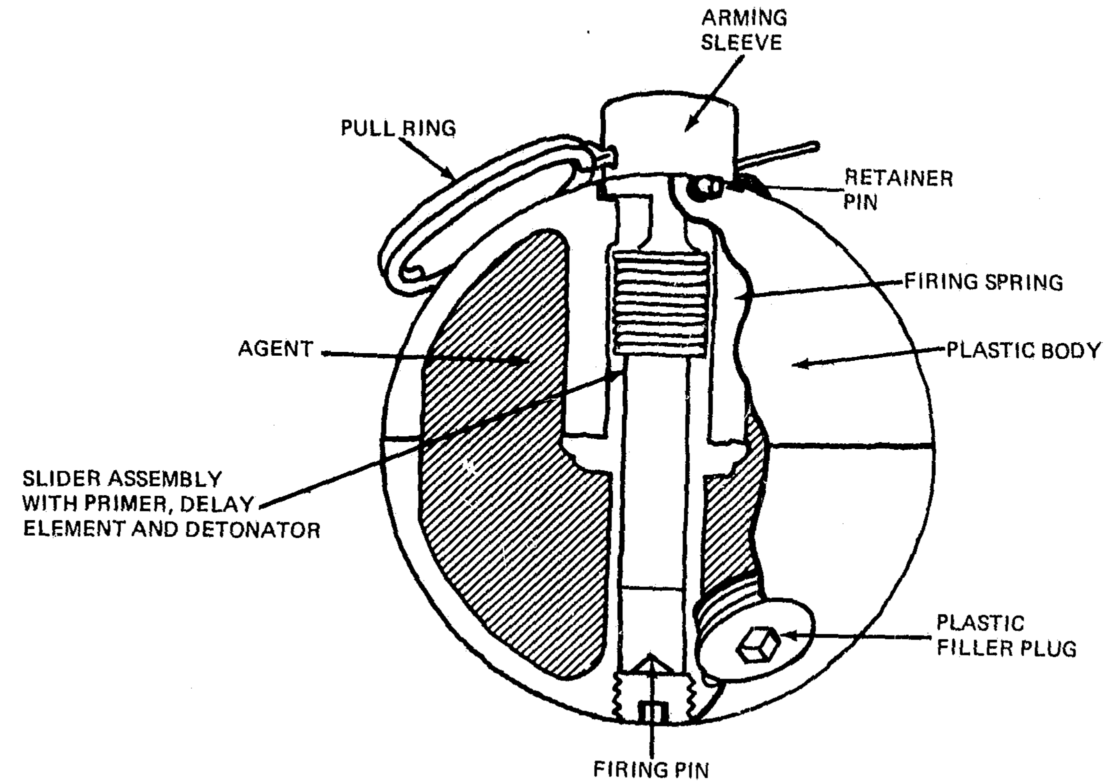
CONTAINER BODY MATERIAL Steel
HEIGHT 6-1/4 inches
DIAMETER 2-3/8 inches at base

MANUFACTURER The Lake Erie Chemical Company

OPERATION Grasp the grenade in the throwing hand with the fingers holding the lever against the body of the grenade. Pull out the arming pin by means of the pull ring. Do not relax grip on the lever before throwing. Throw. The lever will fly off allowing the striker to fire the primer. In approximately 1-3/4 seconds the fuze will ignite the expelling charge, blasting the agent charge out of the base of its container into the expansion chamber and ultimately out of the expelling ports. There will be no fragmentation of the grenade body.

*This grenade can be fired from an AR-15 rifle by means of a special launching fin supplied by Lake Erie Chemical Company.

GRENADE, EXPULSION



MILITARY M25A2 BASEBALL GRENADE

DISPERSION EXPULSION

	CN	CS
TOTAL WEIGHT	Not Available	8 ounces
FILLER WEIGHT		55 grams
ACTIVE AGENT (CS)		95%
OTHER		5%
CATALOG NUMBER		Military
CATALOG PRICE (1/69)		
COLOR		Brown

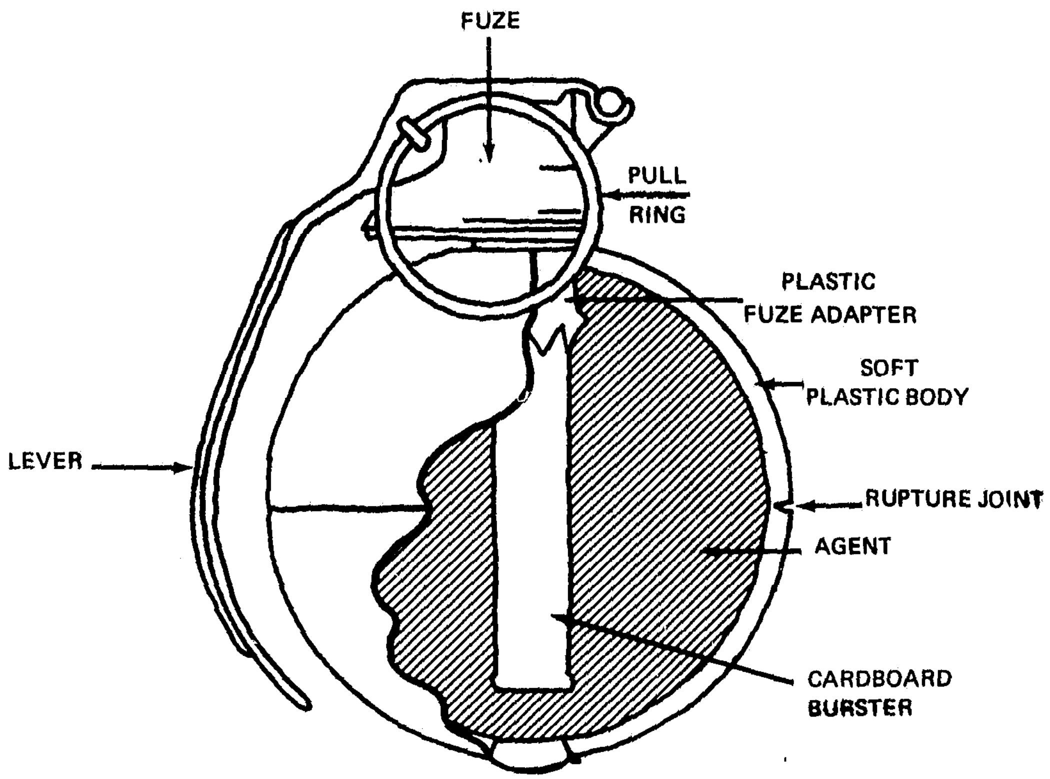
FUZE TIME 1.4 to 3 second
AGENT EMISSION TIME Instantaneous
SHOTGUN LAUNCH Not recommended

CONTAINER BODY MATERIAL Plastic
HEIGHT 3-5/16 with fuse
DIAMETER 2-7/8 inches

MANUFACTURER U.S. Government

OPERATION Grasp the grenade in the throwing hand with thumb firmly depressing the arming sleeve. Pull out the safety pin by means of the pull ring, being careful to keep arming sleeve in place. Throw. Release of the arming sleeve permits the spring-loaded slider to travel the length of the burster well to impact on a firing pin at the bottom of the well, exploding the detonator after a 1.4 to 3 second delay and shattering the grenade and dispersing its filling. The grenade body is fragmented and pieces travel with sufficient velocity to produce injuries. For this reason the grenade should not be exploded close to unprotected personnel.

GRENADE, EXPULSION



PENGUIN BASEBALL GRENADE

	CN	CS
DISPERSION	EXPULSION	
TOTAL WEIGHT	6 ounces	6 ounces
FILLER WEIGHT	40 grams	40 grams
ACTIVE AGENT	20 grams	20 grams
OTHER	20 grams	20 grams
CATALOG NUMBER	G-1	G-8
CATALOG PRICE (1/69)	$9.95	$10.95
COLOR	Brown	Brown

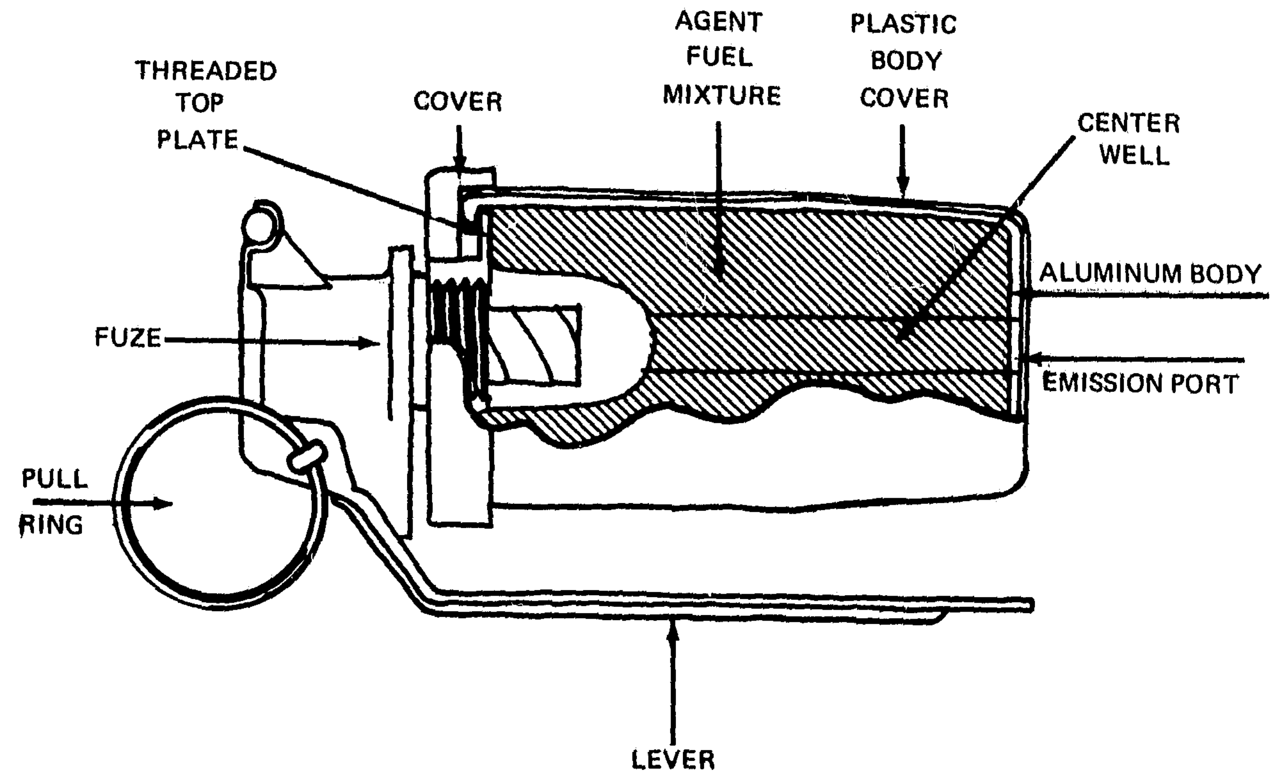
FUZE TIME 4 seconds
AGENT EMISSION TIME Instantaneous
SHOTGUN LAUNCH Not recommended

CONTAINER BODY MATERIAL Plastic
HEIGHT 4 inches
DIAMETER 2-7/8 inches

MANUFACTURER Penguin Industries, Inc.

OPERATION Grasp the grenade in the throwing hand with the fingers holding the lever against the body of the grenade. Pull out the arming pin by means of the pull ring. Do not relax grip on the lever before throwing. Throw. The lever will fly off allowing the striker to fire the primer. Approximately 4 seconds later the fuze will ignite the detonator which will cause the plastic body to rupture into two sections, releasing the agent cloud.

GRENADE, PYROTECHNIC



BRUNSWICK SKITTER GRENADE

	CN	CS
DISPERSION	PYROTECHNIC	
TOTAL WEIGHT	5 ounces	5 ounces
FILLER WEIGHT	38 grams	38 grams
ACTIVE AGENT	16 grams	16 grams
OTHER	22 grams	22 grams
CATALOG NUMBER	6001	5001
CATALOG PRICE (1/69)	$3.50	$3.50
COLOR	Black, red top	Black, blue top

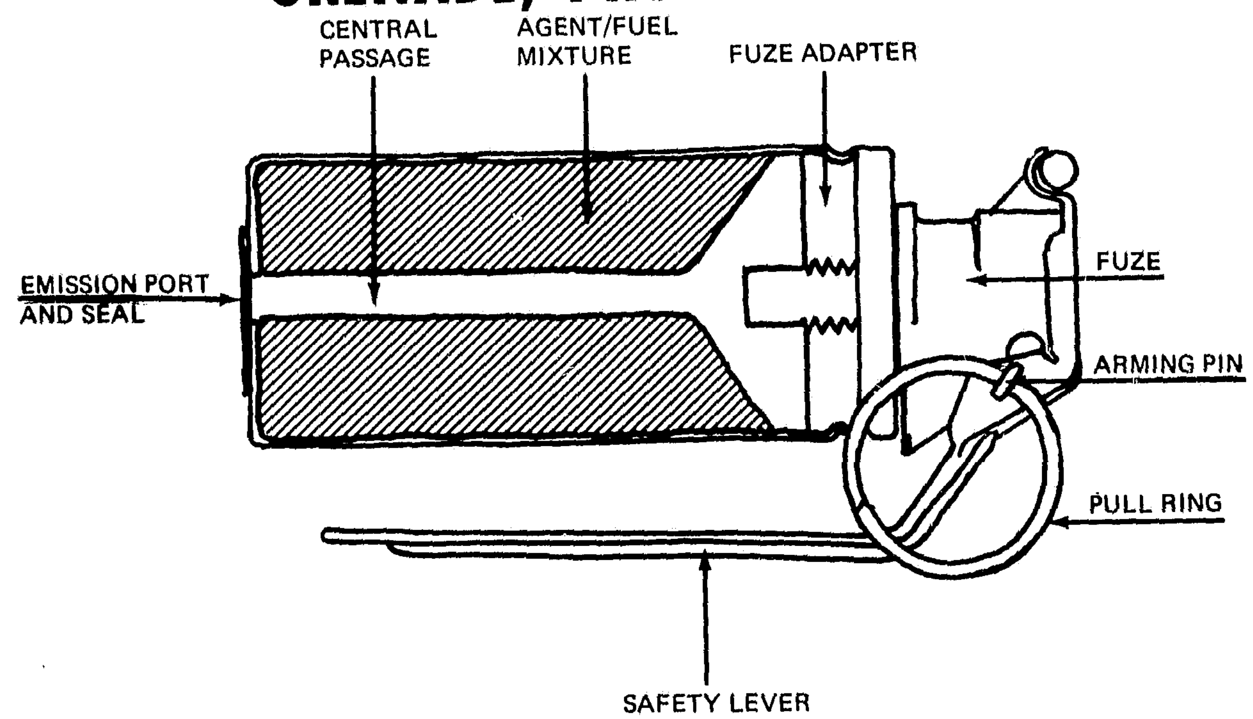
FUZE TIME 1-1/2 seconds
AGENT EMISSION TIME 10-15 seconds (CN 20 seconds)
SHOTGUN LAUNCH Not recommended

CONTAINER BODY MATERIAL Plastic covered aluminum
HEIGHT 4 inches with fuze
DIAMETER 1-3/8 inches

MANUFACTURER Brunswick Corporation

OPERATION Grasp the grenade in the throwing hand with the fingers holding the lever tight against the body of the grenade. Pull out arming pin by means of the pull ring. Do not relax grip on the lever before throwing. Throw. The lever will fly off allowing the striker to fire the primer. Approximately one and a half seconds later the fuze will ignite the charge and the agent cloud will be discharged through a hole ruptured in the base of the grenade body. There will be no explosion or fragmentation of the grenade body.

GRENADE, PRYOTECHNIC



FEDERAL 109 POCKET GRENADE

	CN	CS
DISPERSION PYROTECHNIC		
TOTAL WEIGHT	6 ounces	6 ounces
FILLER WEIGHT	50 grams	50 grams
ACTIVE AGENT	20 grams	20 grams
OTHER	30 grams	30 grams
CATALOG NUMBER	109 CN	109 CS
CATALOG PRICE	$ 3.75	$3.75
COLOR	Red	Blue

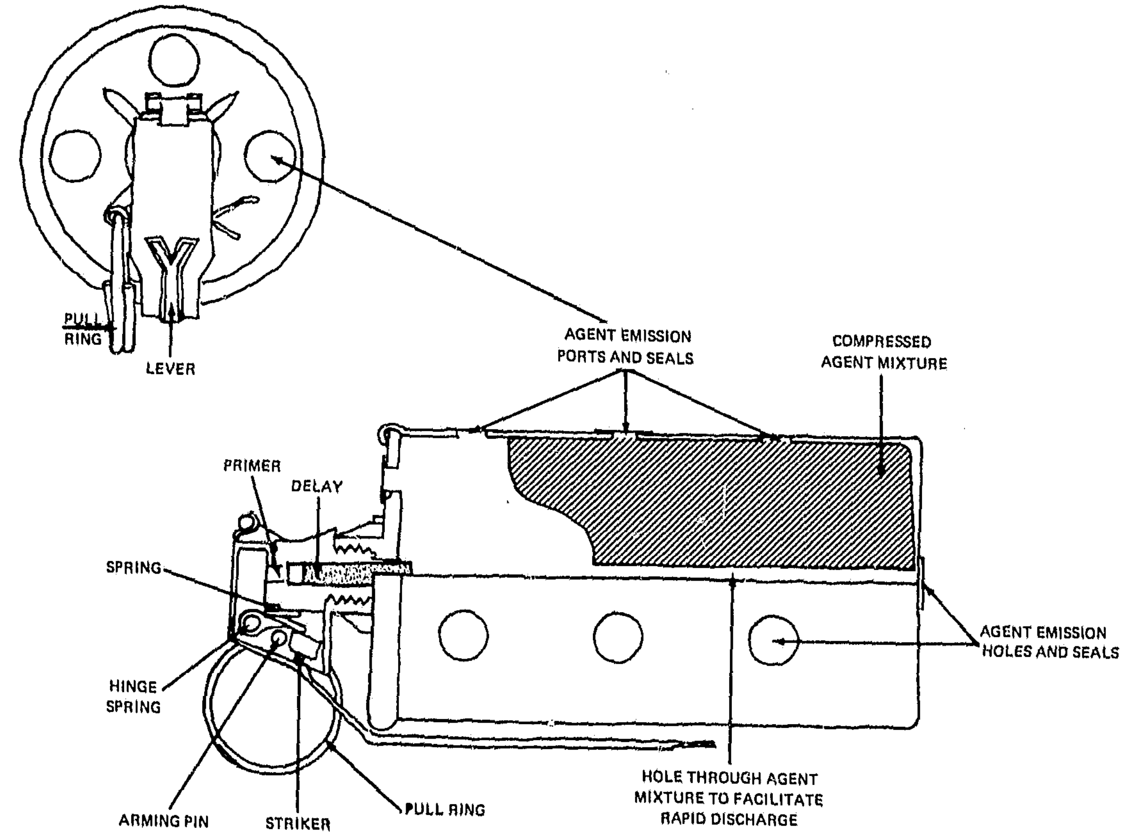
FUZE TIME 1-1/2 seconds
AGENT EMISSION TIME 16 seconds
SHOTGUN LAUNCH Not recommended

CONTAINER BODY MATERIAL Aluminum
HEIGHT 4-1/8 inches
DIAMETER 1-3/8 inches

MANUFACTURER Federal Laboratories, Inc.

OPERATION Grasp the grenade in the throwing hand with the fingers holding the lever tight against the body of the grenade. Pull out arming pin by means of the pull ring. Do not relax grip on the lever before throwing. Throw. The lever will fly off allowing the striker to fire the primer. Approximately one and a half seconds later the fuze will ignite the charge and the agent cloud will be discharged through an emission port in the base of the grenade body. There will be no explosion or fragmentation of the grenade body.

GRENADE, PYROTECHNIC



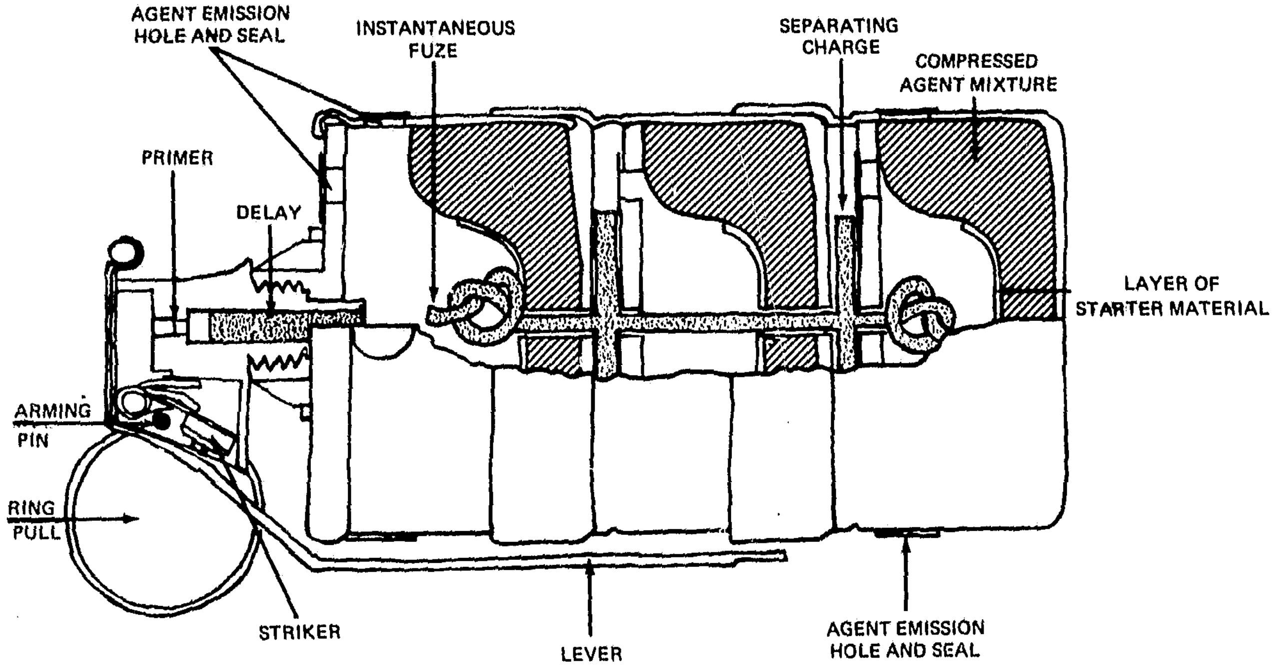
FEDERAL SPEDEHEAT GRENADE

	CN	CS
DISPERSION PYROTECHNIC		
TOTAL WEIGHT	20½ ounces	20 ounces
FILLER WEIGHT	370 grams	380 grams
ACTIVE AGENT	124 grams	104 grams
OTHER	246 grams	276 grams
CATALOG NUMBER	112	555
CATALOG PRICE (1/69)	$11.30	$11.30
COLOR	Red	Blue

FUZE TIME 1 second
AGENT EMISSION TIME 25-35 seconds
SHOTGUN LAUNCH Yes
CONTAINER BODY MATERIAL Aluminum
HEIGHT 6-1/4 inches with fuze
DIAMETER 2-5/8 inches at base

MANUFACTURER Federal Laboratories, Inc.

OPERATION Grasp the grenade in the throwing hand with the fingers holding the lever against the body of the grenade. Pull out arming pin by means of the pull ring. Do not relax grip on the lever before throwing. Throw. The lever will fly off allowing the striker to fire the primer. Approximately one second later the fuze will ignite the charge and agent will come out of the emission holes. The discharge will last for about 35 seconds. There will be no explosion or fragmentation of the grenade body.



FEDERAL TRIPLE CHASER GRENADE

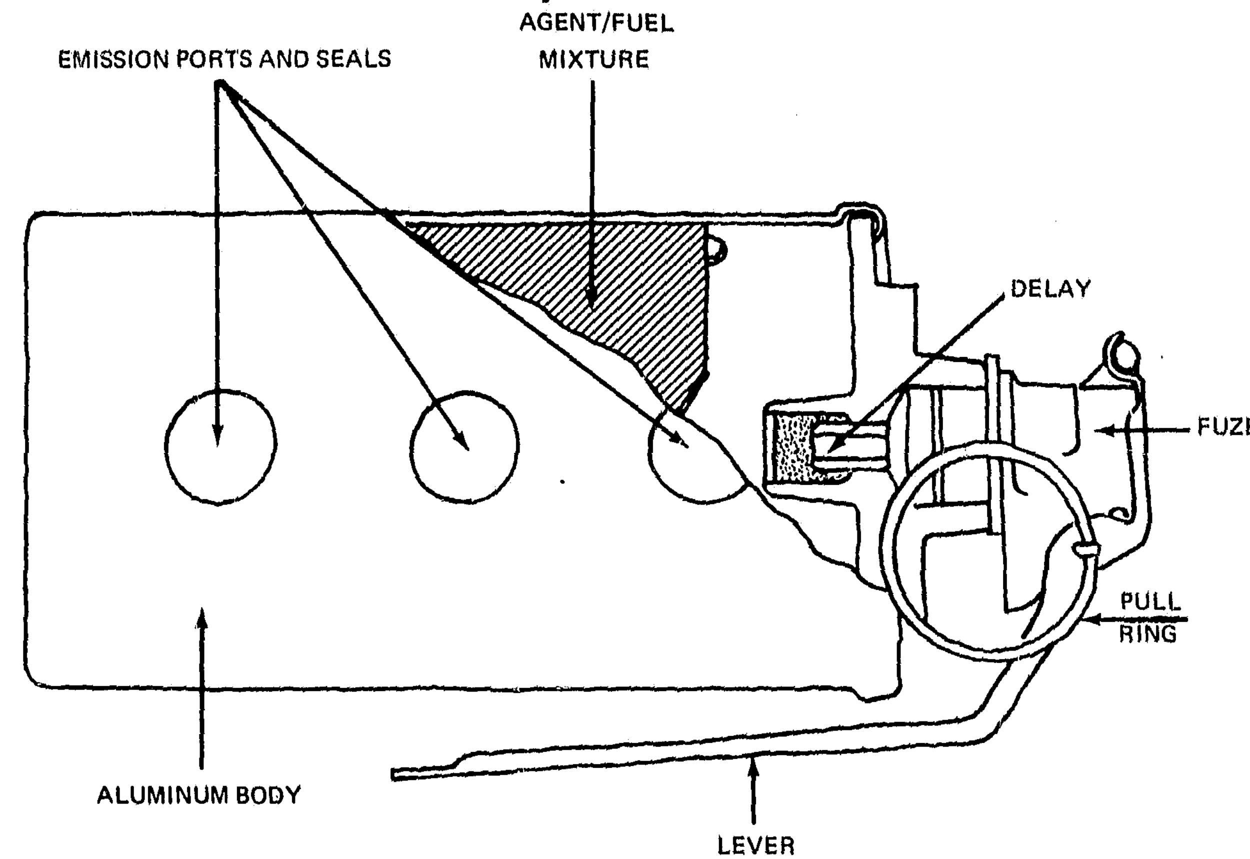
	CN	CS
DISPERSION PYROTECHNIC		
TOTAL WEIGHT	24 ounces	20½ ounces
FILLER WEIGHT	290 grams	265 grams
ACTIVE AGENT	92 grams	72 grams
OTHER	198 grams	193 grams
CATALOG NUMBER	115	515
CATALOG PRICE (1/69)	$13.75	$13.75
COLOR	Red	Blue

FUZE TIME 2 seconds
AGENT EMISSION TIME 25-35 seconds
SHOTGUN LAUNCH Not Recommended

CONTAINER BODY MATERIAL Aluminum
HEIGHT 6-1/4 inches with fuze
DIAMETER 2-5/8 inches at base

MANUFACTURER Federal Laboratories, Inc.

OPERATION Grasp the grenade in the throwing hand with the fingers holding the lever tight against the body of the grenade. Pull out the arming pin by means of the pull ring. Do not relax grip on the lever before throwing. Throw. The lever will fly off allowing the striker to fire the primer. Approximately two seconds later the fuze will ignite the charge, and at the same time separate the grenade into 3 parts which will bounce along the ground and function like 3 separate grenades. Agent will come out of the emission holes in each section. The agent discharge will last for about 25 seconds. There will be no further explosion or fragmentation of the 3 sections once the initial separation is complete.



LAKE ERIE CONTINUOUS DISCHARGE GRENADE

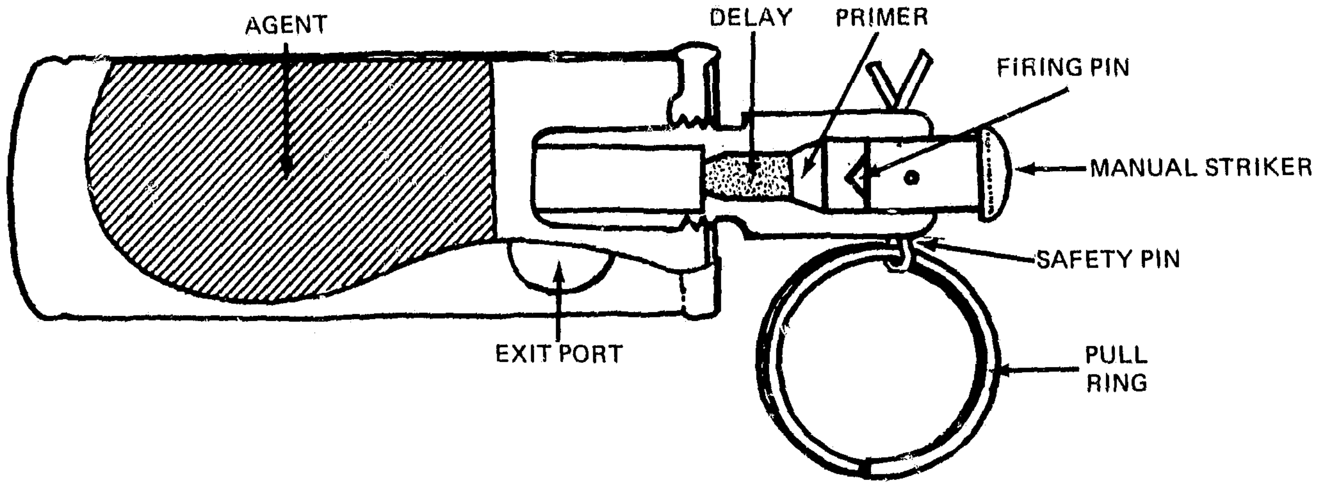
	CN	CS
DISPERSION PYROTECHNIC		
TOTAL WEIGHT	15 ounces	15½ ounces
FILLER WEIGHT	306 grams	285 grams
ACTIVE AGENT	128 grams	106 grams
OTHER	178 grams	179 grams
CATALOG NUMBER	2CN	2CS
CATALOG PRICE (1/69)	$11.30	$11.30
COLOR	Red	Blue

FUZE TIME 2 seconds
AGENT EMISSION TIME 25-30 seconds
SHOTGUN LAUNCH Yes

CONTAINER BODY MATERIAL Aluminum
HEIGHT 6-1/2 inches with fuse
DIAMETER 2-5/8 inches at base

MANUFACTURER The Lake Erie Chemical Company

OPERATION Grasp the grenade in the throwing hand with the fingers holding the lever against the body of the grenade. Pull out the arming pin by means of the pull ring. Do not relax grip on the lever before throwing. Throw. The lever will fly off allowing the striker to fire the primer. Approximately two seconds later the fuze will ignite the charge and the agent will come out of emission holes located on the body of the grenade. Agent discharge will last for about 25-30 seconds. There will be no explosion or fragmentation of the grenade body.



LAKE ERIE MIGHTY MIDGET

	CN	CS
DISPERSION	PYROTECHNIC	
TOTAL WEIGHT	4 ounces	4 ounces
FILLER WEIGHT	50 grams	50 grams
ACTIVE AGENT	17.5 grams	14 grams
OTHER	32.5 grams	36 grams
CATALOG NUMBER	98 CN	98 CS
CATALOG PRICE (1/69)	$3.75	$3.75
COLOR	Red	Blue

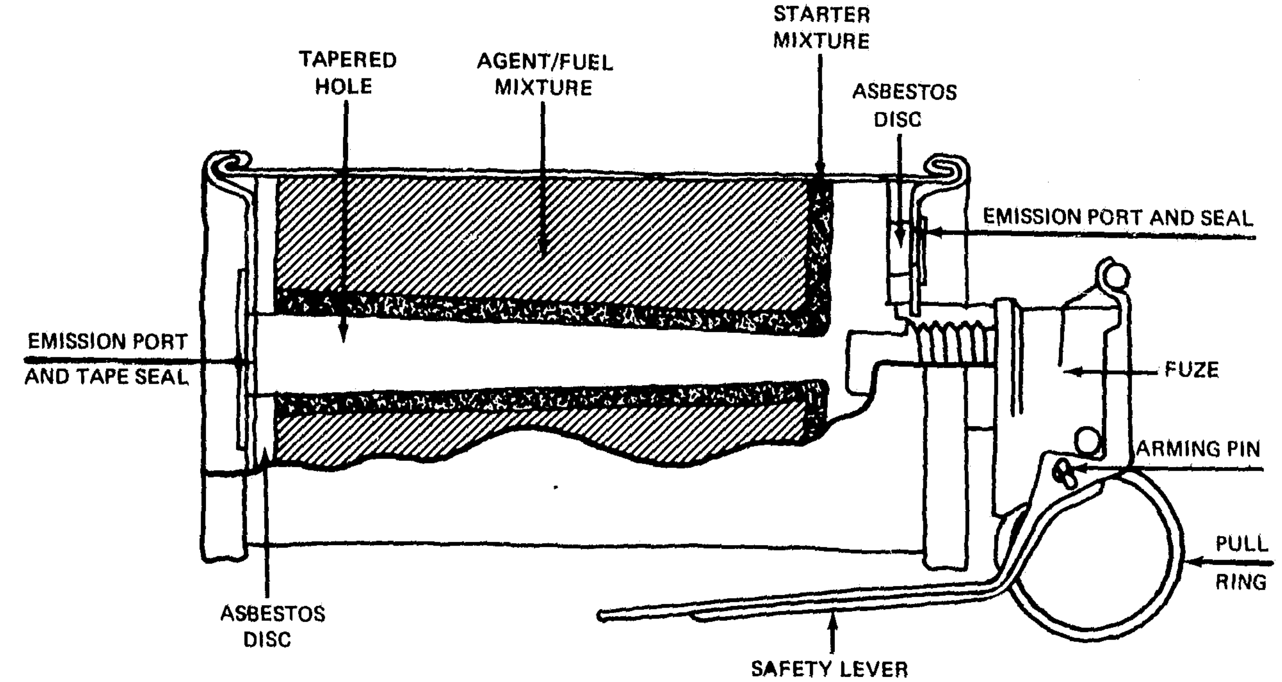
FUZE TIME 2.5 seconds
AGENT EMISSION TIME Minimum 15-20 seconds
LAUNCH From .38 cal. service revolver or 12 gauge riot shotgun

CONTAINER BODY MATERIAL Aluminum
HEIGHT 5 inches with fuze
DIAMETER 1-3/8 inches

SOURCE The Lake Erie Chemical Company

OPERATION Grasp the grenade in the throwing hand and pull out arming pin by means of the pull ring. Strike the head of the manual percussion type fuze sharply against shoe sole, holster, or other firm surface. The blow will drive the manual striker against the primer, which initiates the delay prior to ignition of the fuel/agent mixture. During burning, the agent/smoke cloud exits from ports located on the upper sides of the body of the grenade. There will be no explosion or fragmentation of the grenade body.

A launcher is available for the .38 cal. service revolver and 12 gauge shotgun that will permit this grenade to be launched for distances up to 100 yards.



MILITARY M7A3 GRENADE

	CN	CS
DISPERSION	PYROTECHNIC	
TOTAL WEIGHT	Not Available	16 ounces
FILLER WEIGHT		339 grams
ACTIVE AGENT		128 grams
OTHER		211 grams
CATALOG NUMBER		Military
CATALOG PRICE (1/69)		
COLOR		Gray

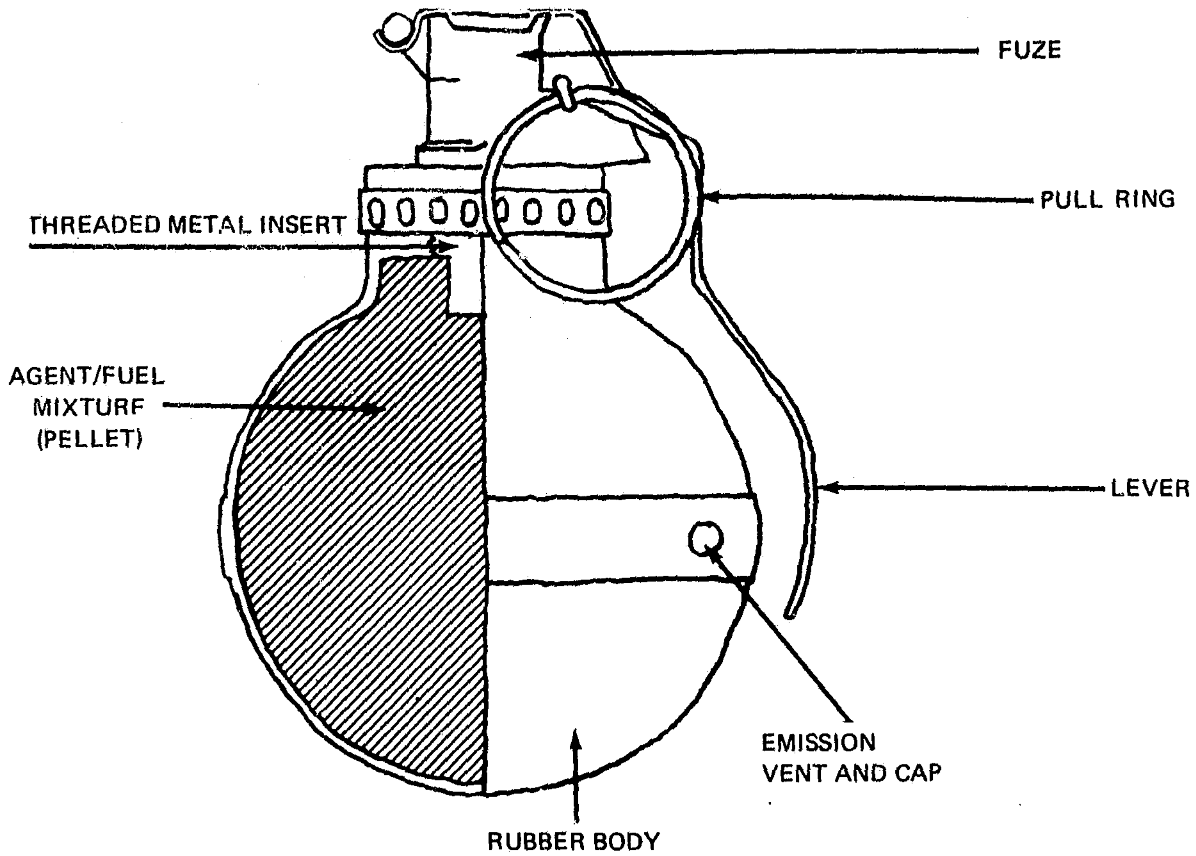
FUZE TIME 0.7 to 2.0 seconds
AGENT EMISSION TIME 15-35 seconds
SHOTGUN LAUNCH Rifle launch

CONTAINER BODY MATERIAL Steel
HEIGHT 5-3/4 inches
DIAMETER 2-1/4 inches

MANUFACTURER U.S. Government

OPERATION Grasp the grenade in the throwing hand with the fingers holding the lever against the body of the grenade. Pull out arming pin by means of the pull ring. Do not relax grip on the lever before throwing. Throw. The lever will fly off allowing the striker to fire the primer. 0.7 to 2.0 seconds later the fuze will ignite the charge and the agent cloud will be discharged from emission holes located in the top and bottom of the grenade body. The M7A2 differs from the M7A3 grenade only in the way in which the filling is manufactured.

GRENADE, PYROTECHNIC



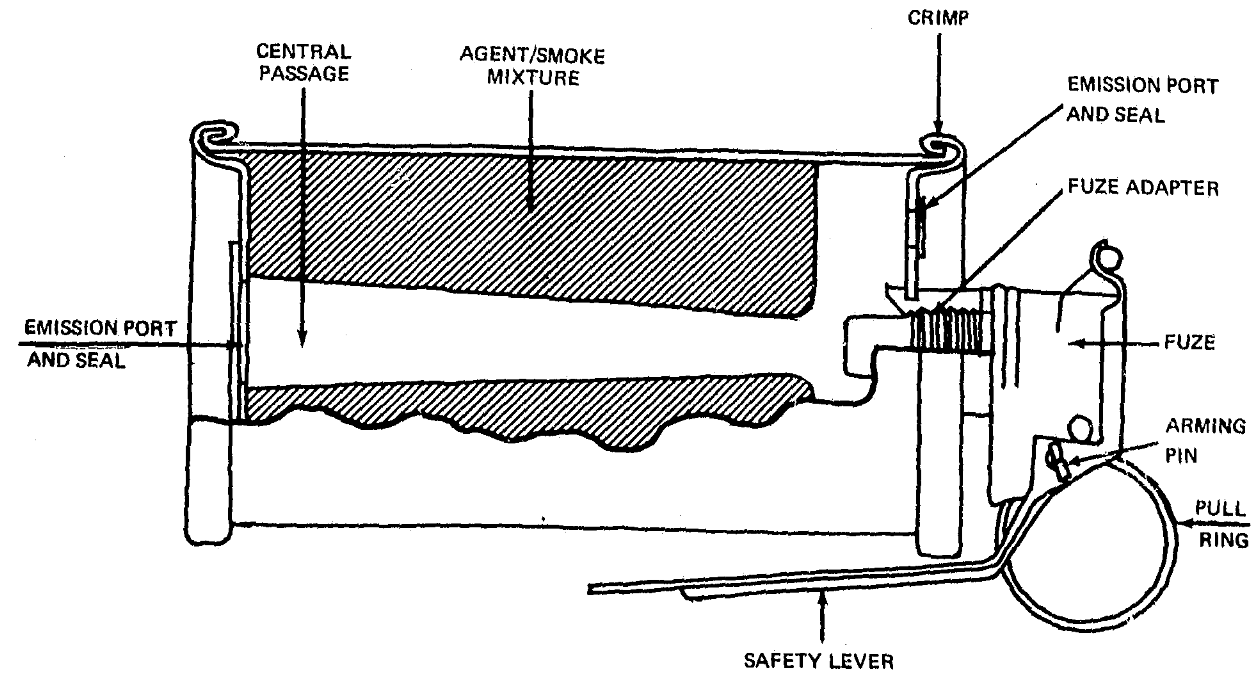
NORTHROP RUBBER BALL GRENADE (AVAILABLE MAY 1969)

		CN	CS
DISPERSION	PYROTECHNIC		
TOTAL WEIGHT		Not Available	0.46 pounds
FILLER WEIGHT			100 grams
ACTIVE AGENT			60 grams
OTHER			40 grams
CATALOG NUMBER			N-9219
CATALOG PRICE (5/69)			$13 Approx.
COLOR			Black

FUZE TIME	2.5 seconds
AGENT EMISSION TIME	10 seconds
SHOTGUN LAUNCH	Not recommended
CONTAINER BODY MATERIAL	Rubber
HEIGHT	4-3/4 inches
DIAMETER	3-1/4 inches
MANUFACTURER	Northrop Carolina, Inc.

OPERATION Grasp the grenade in the throwing hand with the fingers holding the lever tight against the body of the grenade. Pull out arming pin by means of the pull ring. Do not relax grip on the lever before throwing. Throw. The lever will fly off allowing the striker to fire the primer. Approximately 2.5 seconds later the fuze will ignite the charge and the agent cloud will come out of four emission holes located in the body of the grenade. During discharge the grenade moves rapidly along the ground, propelled by the escaping agent. There will be no explosion or fragmentation of the grenade body, in as much as this is a soft munition.

GRENADE, PYROTECHNIC



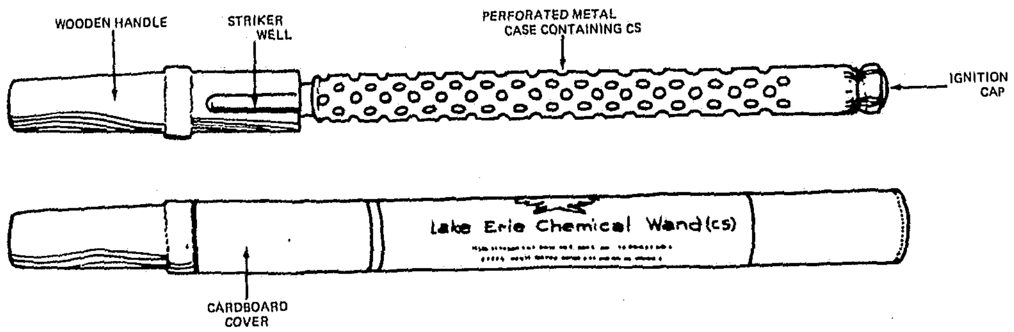
PENGUIN BURNING GRENADE

		CN	CS
DISPERSION	PYROTECHNIC		
TOTAL WEIGHT		14 ounces	NR
FILLER WEIGHT		230 grams	NR
ACTIVE AGENT		69 grams	NR
OTHER		161 grams	NR
CATALOG NUMBER		G-3	NR
CATALOG PRICE (1/69)		$9.95	NR
COLOR		Silver	NR

FUZE TIME	4 seconds
AGENT EMISSION TIME	40 seconds
SHOTGUN LAUNCH	Yes
CONTAINER BODY MATERIAL	Steel
HEIGHT	5-3/4 inches
DIAMETER	2-1/2 inches
MANUFACTURER	Penguin Industries, Inc.

OPERATION Grasp the grenade in the throwing hand with the fingers holding the lever against the body of the grenade. Pull out arming pin by means of the pull ring. Do not relax grip on the lever before throwing. Throw. The lever will fly off allowing the striker to fire the primer. Approximately four seconds later the fuze will ignite the filler mixture and the smoke/agent cloud will exit through the emission ports.

WAND, PYROTECHNIC



LAKE ERIE CHEMICAL WAND

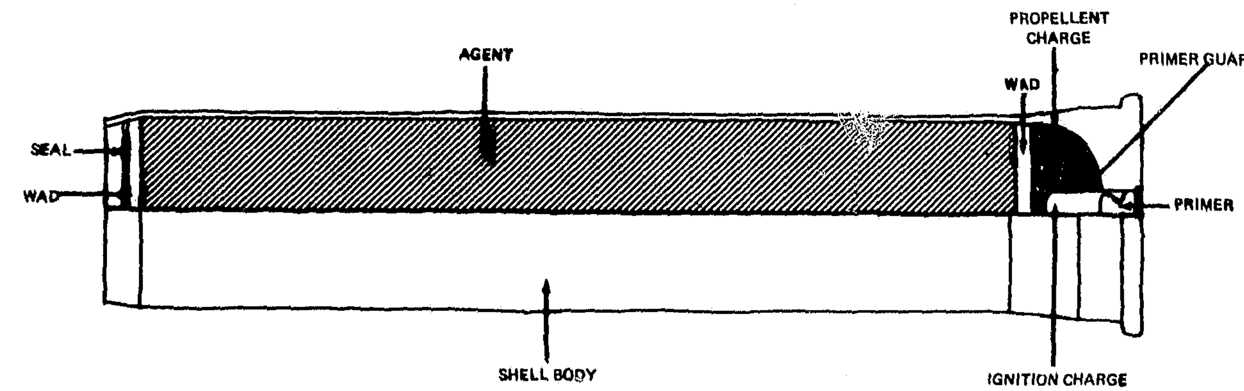
		CS
DISPERSION		PYROTECHNIC
TOTAL WEIGHT	Not Available	6 ounces
FILLER WEIGHT		64 grams
ACTIVE AGENT		16 grams
OTHER		48 grams
CATALOG NUMBER		97
CATALOG PRICE (1/69)		$9.95
COLOR		Blue label over grey background

FUZE TIME	Instantaneous ignition with striker
AGENT EMISSION TIME	4 to 5 min.
CONTAINER BODY MATERIAL	Metal with wooden handle
HEIGHT	Encased 16-3/4"/extended for use 28-1/4"
DIAMETER	
SOURCE	The Lake Erie Chemical Company

OPERATION The chemical wand is ignited by striking the ignition mixture with the striker provided. When ignited, the wand burns downward at a controlled rate, disseminating a continuing cloud of agent.

The wand is useful under training conditions and also provides an effective dissemination to break up sit-in demonstrations and other low-violence situations where controlled applications are appropriate.

CARTRIDGE, EXPULSION



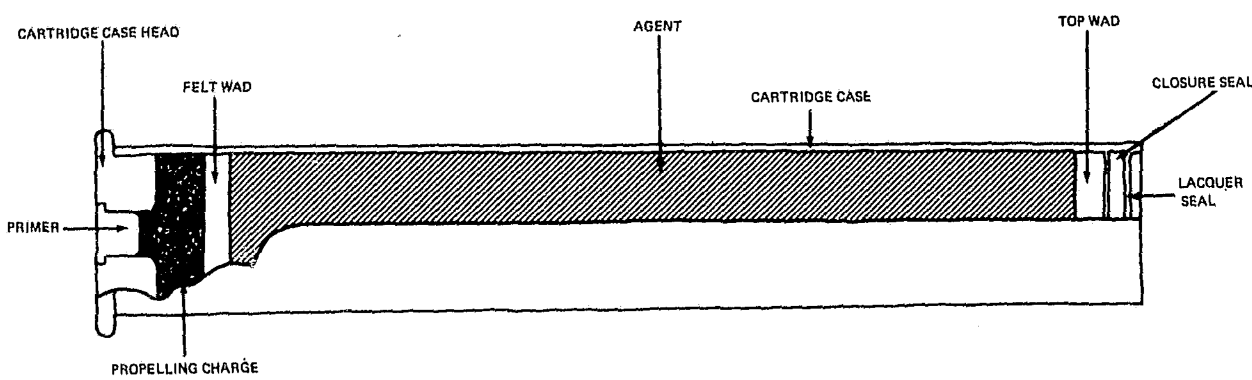
FEDERAL SHORT RANGE SHELL

	CN	CS
DISPERSION	EXPULSION	
TOTAL WEIGHT	8 ounces	8 ounces
FILLER WEIGHT	100 grams	100 grams
ACTIVE AGENT	70 grams	70 grams
OTHER	30 grams	30 grams
CATALOG NUMBER	No. 203	No. 501
CATALOG PRICE (1/69)	$ 6.40	$ 6.40
COLOR	Silver, Red seal	Silver, Blue seal

AGENT EMISSION TIME	Instantaneous
MAXIMUM RANGE	25-30 feet in still air
CALIBER	1½ (38mm)
BODY MATERIAL	Aluminum
MANUFACTURER	Federal Laboratories, Inc.

OPERATION Open the gas riot gun and insert the shell. Close the gun. Hold the gun firmly against the shoulder and fire like a shot gun, aiming at the belt level of the target. In still air the maximum immediate range is about 30 feet, but a favorable wind will carry the agent to more than 50 yards. When this shell is fired a cloud of micropulverized agent is blasted directly from the muzzle of the gun. With the exception of three light wads, the entire discharge consists of filler. This munition can be fired from both 37 and 38mm weapons.

CARTRIDGE, EXPULSION



LAKE ERIE SHORT RANGE SHELL

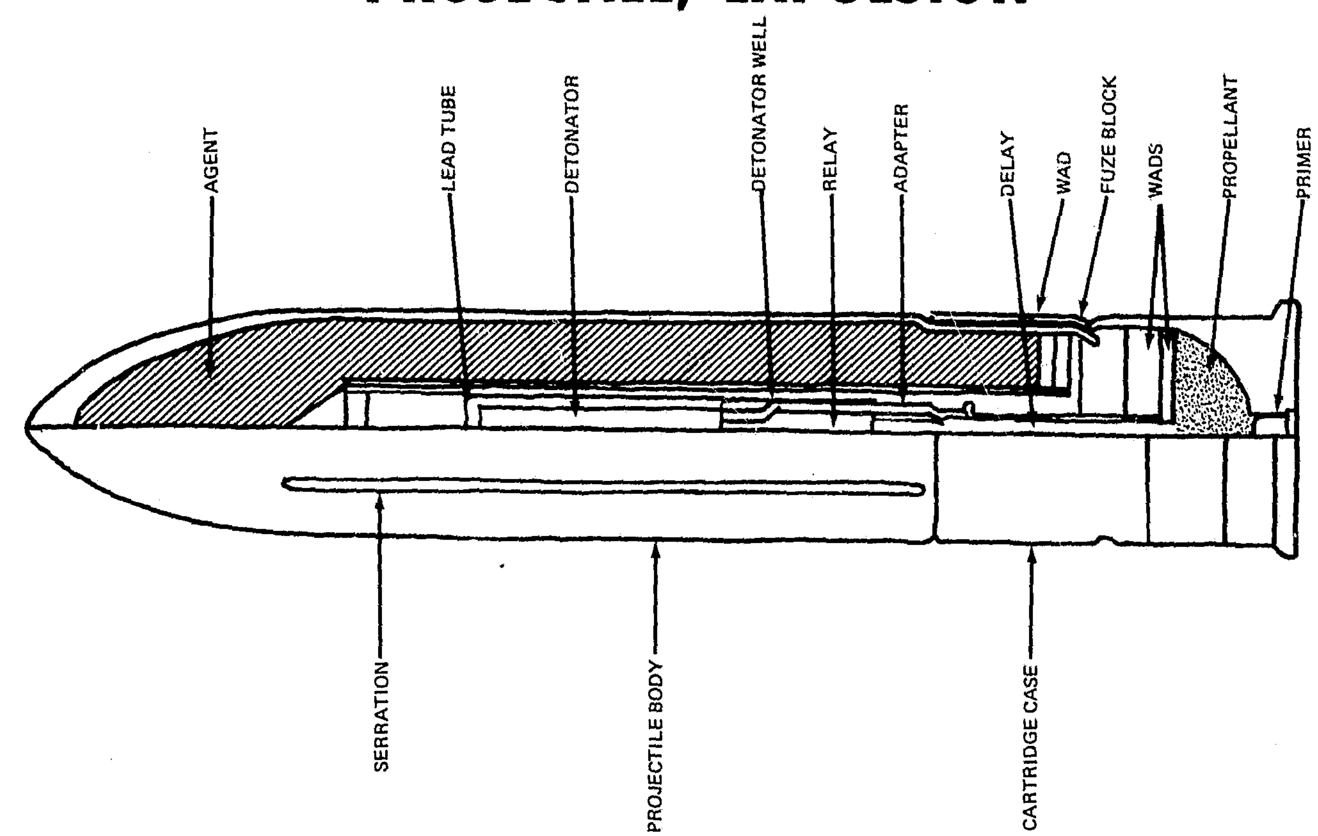
	CN	CS
DISPERSION EXPULSION		
TOTAL WEIGHT	12 ounces	14 ounces
FILLER WEIGHT	114 grams	100 grams
ACTIVE AGENT	97 grams	50 grams
OTHER	17 grams	50 grams
CATALOG NUMBER	21 CN	21 CS
CATALOG PRICE (1/69)	$6.40	$6.40
COLOR	Silver, red seal	Silver, blue seal

AGENT EMISSION TIME	Instantaneous
MAXIMUM RANGE	20 feet in still air
CALIBER	1-1/2 (37mm)
BODY MATERIAL	Steel
MANUFACTURER	The Lake Erie Chemical Company

OPERATION Open the gas riot gun and insert the shell. Close the gun. Hold the gun firmly against the shoulder and fire like a shotgun, aiming at the belt level of the target. In still air the maximum immediate range is about 20 feet, but a favorable wind will carry the agent to a distance of more than 50 yards. When the shell is fired a cloud of micropulverized agent is blasted directly from the muzzle of the gun.

This munition can be fired from 37 or 38mm weapons.

PROJECTILE, EXPULSION



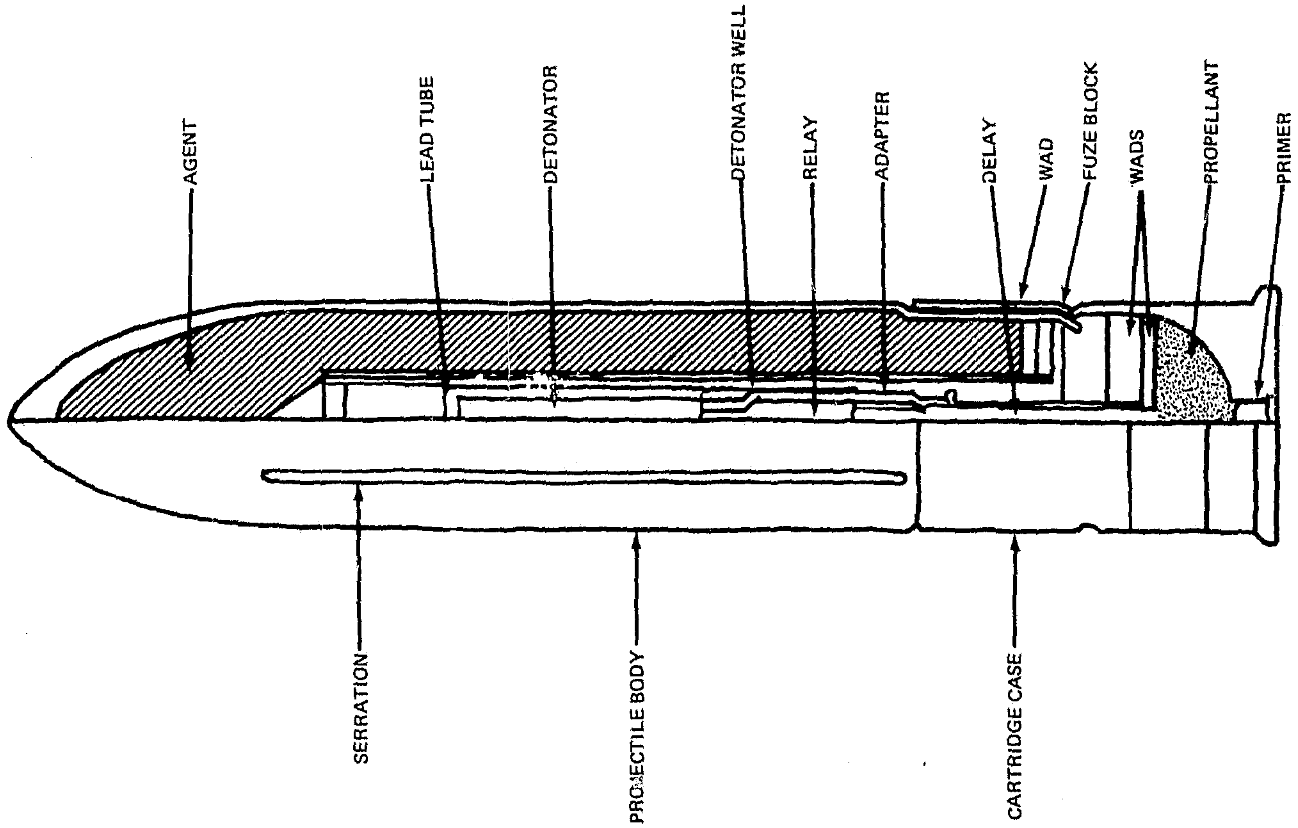
FEDERAL MARK 200 PROJECTILE (CS)
FEDERAL BLAST DISPERSION PROJECTILE (CN)

	CN	CS
DISPERSION EXPULSION		
TOTAL WEIGHT	8.5 ounces	8.5 ounces
FILLER WEIGHT	80 grams	80 grams
ACTIVE AGENT	55 grams	55 grams
OTHER	25 grams	25 grams
CATALOG NUMBER	233	507
CATALOG PRICE (1/69)	$9.40	$9.40
COLOR	Red	Blue

DELAY TIME	3 seconds
AGENT EMISSION TIME	Instantaneous
MAXIMUM RANGE	150 yards
MUZZLE VELOCITY	225 feet per second
CALIBER	1½ (38mm)
BODY MATERIAL	Aluminum
MANUFACTURER	Federal Laboratories, Inc.

OPERATION Open the gas riot gun by pulling up on the rear of the breech lock. Insert the shell. Close the gun. Hold the gun firmly against the shoulder and fire like a shot gun. This munition can be fired from both 37 and 38mm weapons.

When the gun is fired the projectile is propelled from the gun and the delay fuze ignited. In approximately three (3) seconds the burster is ignited and the projectile then opens along the rupture grooves and releases a cloud micropulverized agent. The discharge is instantaneous. The metal projectile will remain in one piece and will not throw off fragments. At 37.5° elevation, the shell will hit the ground at about 150 yards. Shorter ranges are secured by bouncing the shell along the ground or by firing at very high elevations.



FEDERAL MARK 70 PROJECTILE (CS)
FEDERAL BLAST DISPERSION PROJECTILE (CN)

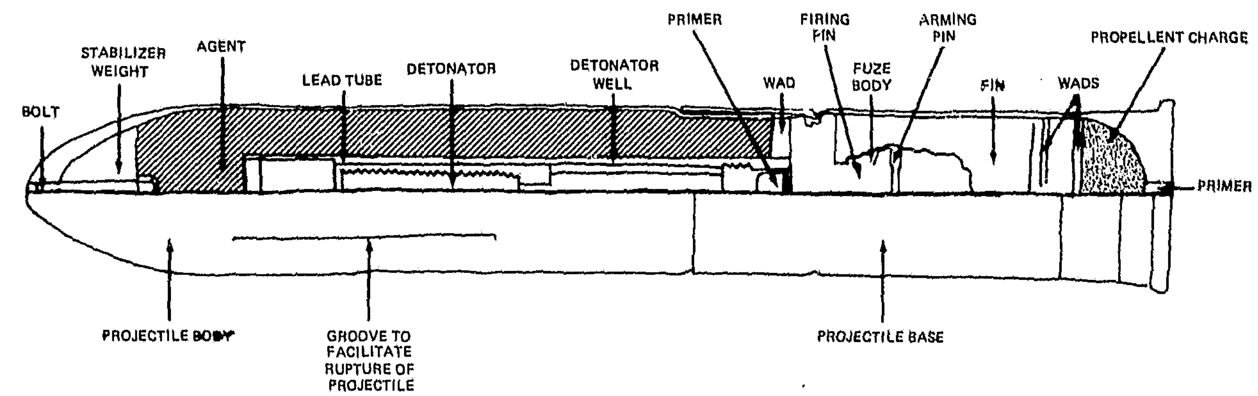
	CN	CS
DISPERSION EXPULSION		
TOTAL WEIGHT	8.5 ounces	8.5 ounces
FILLER WEIGHT	80 grams	80 grams
ACTIVE AGENT	55 grams	55 grams
OTHER	25 grams	25 grams
CATALOG NUMBER	234	505
CATALOG PRICE (1/69)	$9.40	$9.40
COLOR	Red	Blue

DELAY TIME	3 seconds
AGENT EMISSION TIME	Instantaneous
MAXIMUM RANGE	90 yards
MUZZLE VELOCITY	140 feet per second
CALIBER	1½ (38mm)
BODY MATERIAL	Aluminum
MANUFACTURER	Federal Laboratories, Inc.

OPERATION Open the gas riot gun and insert the shell. Close the gun. Hold the gun firmly against the shoulder and fire like a shot gun. This munition can be fired in both 37 and 38mm weapons.

At 37.5° elevation the shell will hit the ground at about 90 yards. Shorter ranges are secured by bouncing the shell along the ground or by firing at very high elevation. When the gun is fired the projectile is propelled from the gun and the delay is ignited. Approximately three (3) seconds later the delay ignites the burster, which ruptures the projectile along rupture grooves to instantaneously release a cloud of micropulverized agent. The aluminum projectile body will remain in one piece and no metal fragments are thrown off during discharge.

This munition is identical with the Mark 200 round except for a reduced propelling charge.



FEDERAL IMPACT FLITE-RITE PROJECTILE

	CN	CS
DISPERSION EXPULSION		
TOTAL WEIGHT	16 ounces	16 ounces
FILLER WEIGHT	80 grams	80 grams
ACTIVE AGENT	55 grams	55 grams
OTHER	25 grams	25 grams
CATALOG NUMBER	No. 232	No. 509
CATALOG PRICE (1/69)	$10.65	$10.65
COLOR	Red	Blue

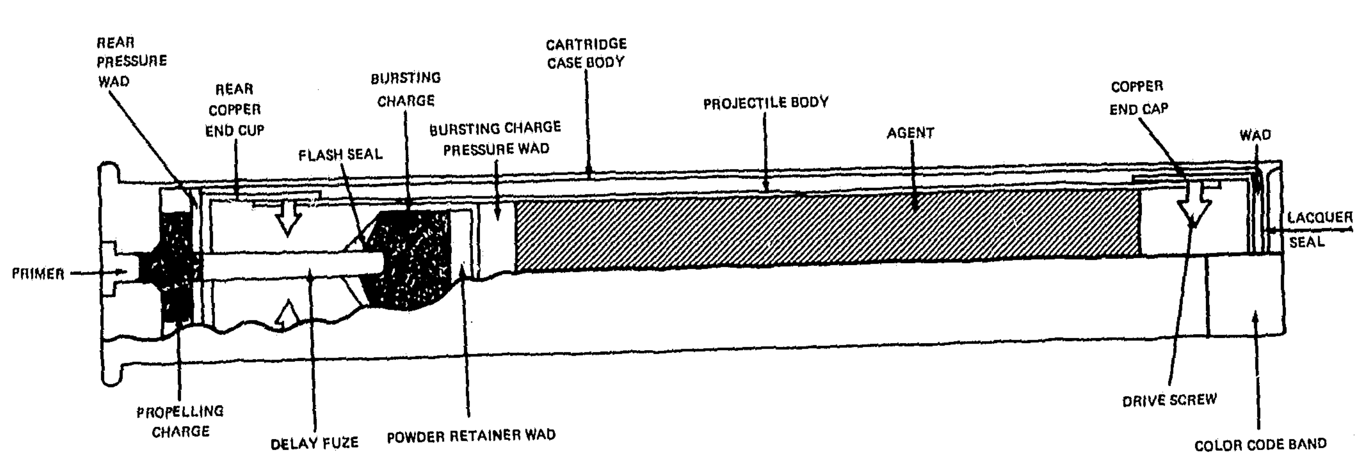
FUZE TIME	On impact
AGENT EMISSION TIME	Instantaneous
MAXIMUM RANGE	325 yards
MUZZLE VELOCITY	180 feet per second
CALIBER	1½ (38mm)
BODY MATERIAL	Aluminum
MANUFACTURER	Federal Laboratories, Inc.

OPERATION Open the gas riot gun by pulling up on the rear of the breech lock. Insert the shell. Close the gun. Hold the gun firmly against the shoulder and fire like a shot gun. The Federal Gas Riot Gun is equipped with a peep sight for use at 50 yard range. This sight is on top of the breech lock. Aperatures for 75 and 100 yard range are located on a leaf sight which must be erected before firing at these ranges. This munition can be fired from both 37 and 38mm weapons.

When the gun is fired the projectile is propelled from the gun. As the projectile leaves the gun 3 fins, or vanes, spring into position. This allows the arming pin to be forced away from the fuze body. This arms the projectile. The action of the fins, plus the stabilizer weight in the nose of the projectile enable this projectile to be fired with considerable accuracy.

When the projectile strikes a solid target the firing pin strikes the primer, which immediately ignites a detonator. The projectile then opens along the rupture grooves and releases a cloud micropulverized agent. The discharge is instantaneous. The metal projectile will remain in one piece and will not throw off fragments.

PROJECTILE, EXPULSION



LAKE ERIE LONG RANGE INSTANTANEOUS DISCHARGE PROJECTILE

		CN	CS
DISPERSION	EXPULSION		
TOTAL WEIGHT		12 ounces	12 ounces
FILLER WEIGHT		67 grams	60 grams
ACTIVE WEIGHT		57 grams	51 grams
OTHER		10 grams	9 grams
CATALOG NUMBER		16 CN	16 CS
CATALOG PRICE (1/69)		$9.40	$9.40
COLOR		Silver, with red band and seal	Silver, with blue band and seal

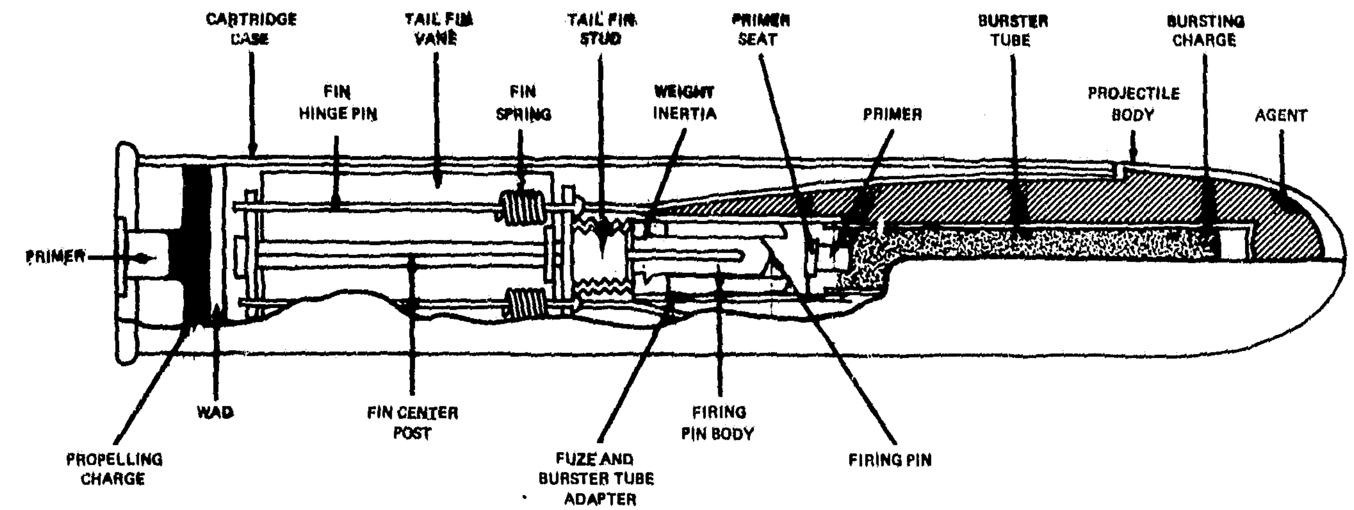
FUZE TIME	6 seconds
AGENT EMISSION TIME	Instantaneous
MAXIMUM RANGE	150 yards
MUZZLE VELOCITY	175 feet per second
CALIBER	1-1/2 (37mm)
BODY MATERIAL	Steel case, aluminum projectile
MANUFACTURER	The Lake Erie Chemical Company

OPERATION Open the gas riot gun and insert the shell. Close the gun and fire like a shotgun with stock firmly against the shoulder. This munition can be fired in both 37 and 38mm weapons.

When the gun is fired the firing pin strikes the primer which ignites the propelling charge producing gases that launch the projectile. The propelling gases also ignite a delay element in the base of the projectile. As it travels through the air, the projectile tumbles and wobbles as a result of the absence of a stabilizing device. Approximately six seconds after ignition, a burster ruptures the projectile, releasing a cloud of micropulverized agent.

The projectile can also be supplied, on special order, with a continuous discharge type container of either CN or CS.

PROJECTILE, EXPLUSION



LAKE ERIE TRU-FLITE BARRICADE PROJECTILE

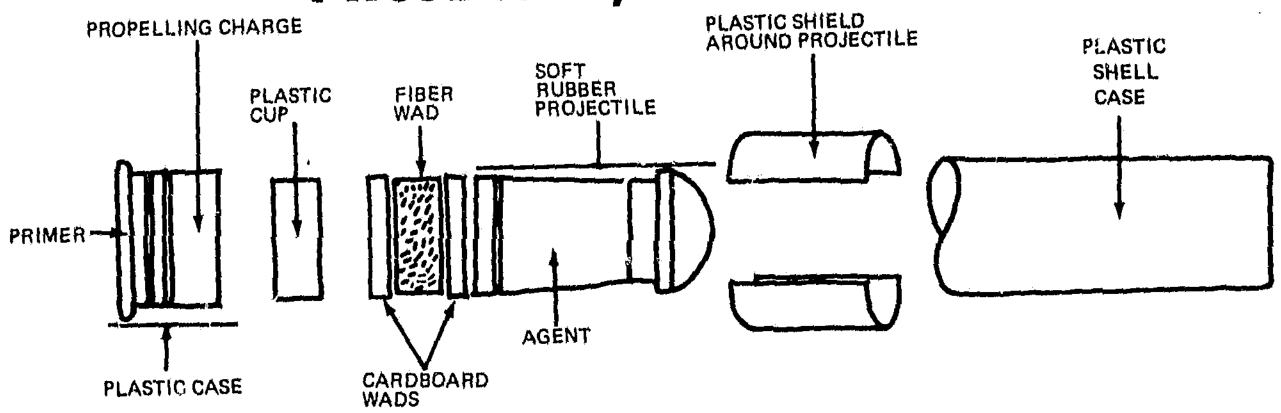
		CN	CS
DISPERSION	EXPULSION		
TOTAL WEIGHT		23.3 ounces	23.3 ounces
FILLER WEIGHT		60 grams	60 grams
ACTIVE AGENT		45 grams	45 grams
OTHER		15 grams	15 grams
CATALOG NUMBER		11 CN	11 CS
CATALOG PRICE (1/69)		$10.65	$10.65
COLOR		Silver, red nose	Silver, blue nose

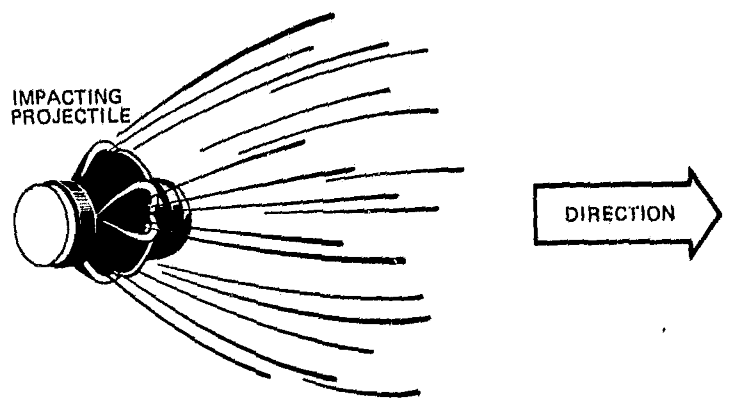
FUZE TIME	On impact
AGENT EMISSION TIME	Instantaneous
MAXIMUM RANGE	350 yards
MUZZLE VELOCITY	225 feet per second
CALIBER	1-1/2 (37mm)
BODY MATERIAL	Steel case, thin steel projectile
MANUFACTURER	The Lake Erie Chemical Company

OPERATION Open the gas riot gun and insert the shell. Close the gun and fire like a shotgun with stock firmly against the shoulder. This munition can be fired in both 37 and 38mm weapons.

When the gun is discharged the firing pin strikes the primer which flashes into the propellant. The resulting deflagration ejects the projectile from the muzzle of the weapon, permitting the spring loaded fins to open and stabilize the projectile in flight. Deceleration upon impact causes the firing pin assembly to move forward and strike the primer, igniting the burster. The projectile ruptures and expels a cloud of micropulverized agent. The body fragments and may eject pieces of steel at a dangerous velocity.

PROJECTILE, EXPULSION





PENGUIN BARRICADE PENETRATING CARTRIDGE

DISPERSION EXPULSION

	CN	CS
FILLER WEIGHT	Not Available	0.75 grams
ACTIVE WEIGHT		0.75 grams
OTHER		None
CATALOG NUMBER		GSA14
CATALOG PRICE (1/69)		$12.50 per box of 5
COLOR		Grey

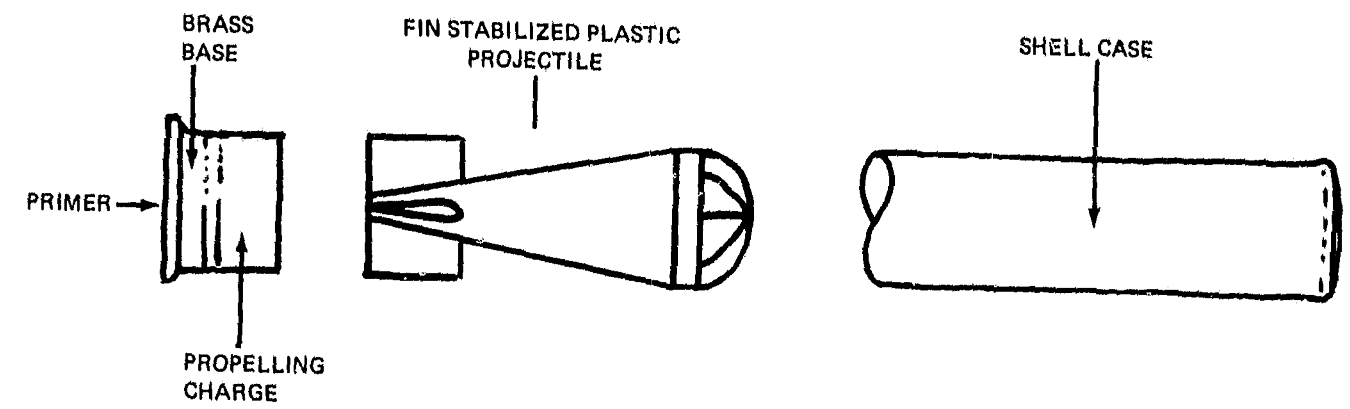
FUZE TIME	Impact
AGENT EMISSION TIME	Instantaneous
MAXIMUM RANGE	75 yards
MUZZLE VELOCITY	1,200 feet per second (estimated)
CALIBER	12 gauge
BODY MATERIAL	Soft Rubber
MANUFACTURER	Penguin Industries, Inc.

OPERATION The Barricaded Penetrating Cartridge is loaded and fired in any standard 12 gauge riot shotgun in the normal manner.

The firing pin strikes the primer, igniting the expelling charge which projects a soft rubber projectile from the bore of the weapon for distances up to 75 yards. Upon impact, the projectile ruptures, releasing the chemical agent load.

The projectile will penetrate 3/4 inch plywood at 30 feet and standard window glass at 30 yards. Under normal conditions, the projectile can be accurately fired at distances up to 35 yards.

PROJECTILE, LIQUID



AAI SGA-100 BARRICADE PROJECTILE

DISPERSION LIQUID

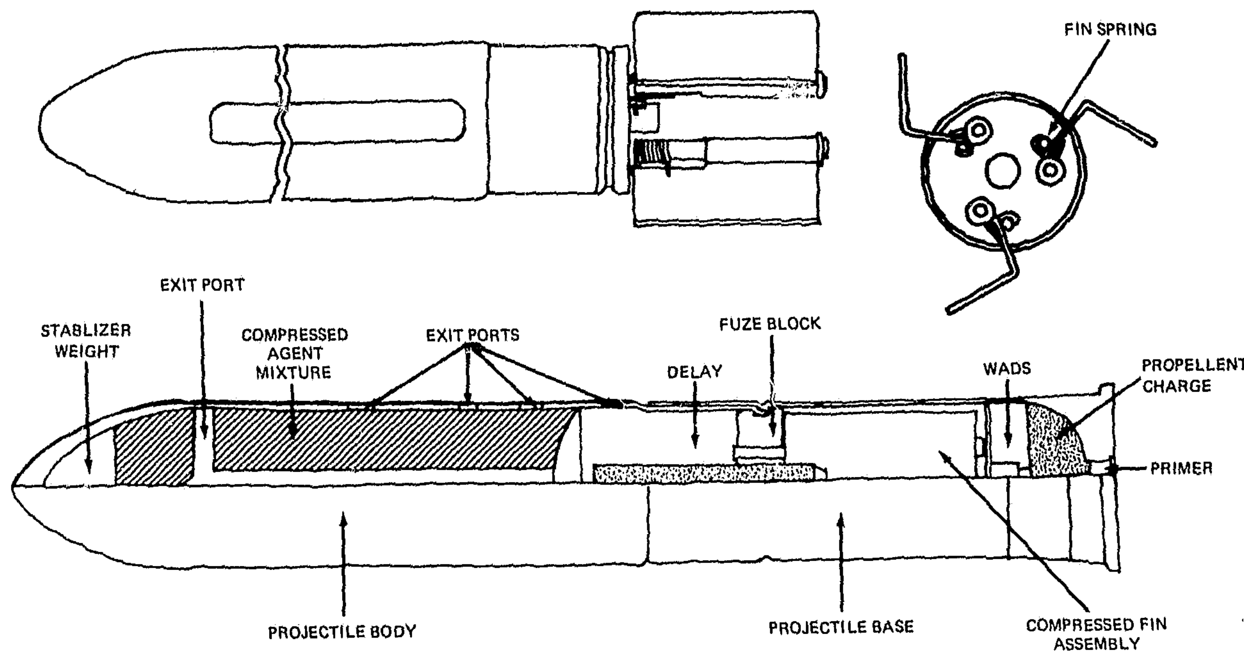
	CN	CS
TOTAL WEIGHT	Not Available	17.2 grams
FILLER WEIGHT		3 cc
ACTIVE AGENT		N/R
OTHER		N/R
CATALOG NUMBER		SGA-100
CATALOG PRICE (1/69)		$ 3.00
COLOR		Red case

FUZE TIME	Impact
AGENT EMISSION TIME	Instantaneous
MAXIMUM RANGE	500 yards
MUZZLE VELOCITY	1000 feet per second
SIZE	12 gauge
BODY MATERIAL	Plastic, Injection Molded
MANUFACTURER	AAI Corporation

OPERATION The AAI projectile may be fired from all unchoked 12 Gauge Shotguns. The injection molded plastic projectile contains 3 cubic centimeters of CS in solution. One round will effectively contaminate a 9 ft. x 12 ft. room. Following impact and perforation of window or plate glass, the projectile disintegrates and instantaneously disseminates the liquid riot agent throughout the enclosed atmosphere in the form of a vapor-micro-particle aerosol. The projectile has a flat trajectory out to 100 yards and is non-lethal beyond 250 yards.

Tests indicate penetration capability against automotive safety glass at 100 ft. range; ¼ inch thick plate glass or double window plus aluminum screen at 100 yard range.

PROJECTILE, PYROTECHNIC



FEDERAL FLITE-RITE PROJECTILE

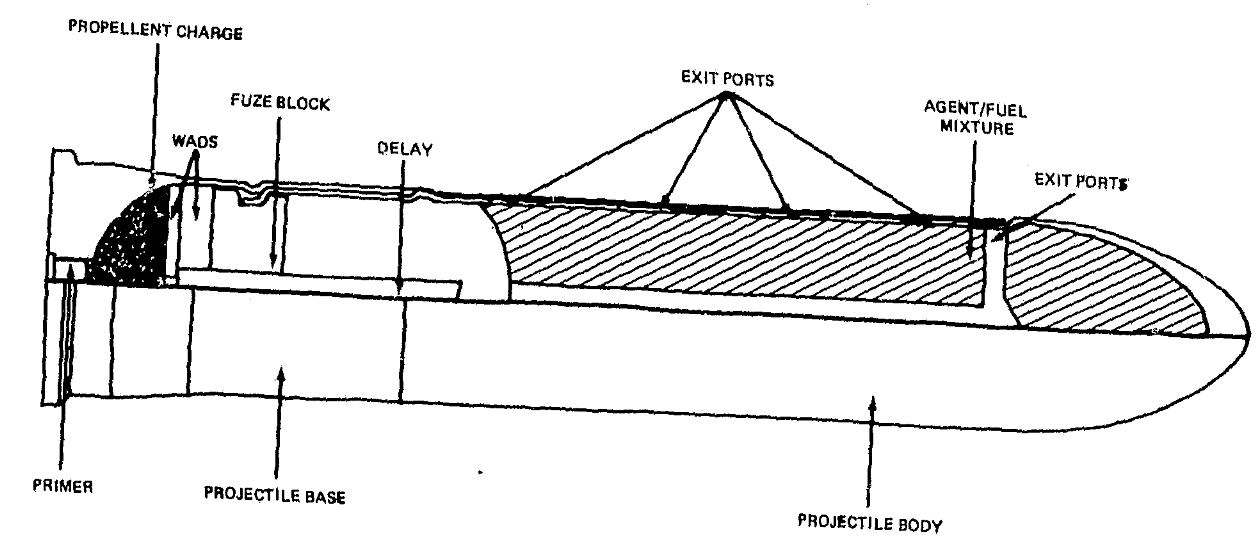
	CN	CS
DISPERSION	PYROTECHNIC	
TOTAL WEIGHT	16.5 ounces	16 ounces
FILLER WEIGHT	145 grams	140 grams
ACTIVE AGENT	42 grams	42 grams
OTHER	103 grams	98 grams
CATALOG NUMBER	No. 230	No. 530
CATALOG PRICE (1/69)	$10.65	$10.65
COLOR	Red	Blue

DELAY TIME	3 seconds
AGENT EMISSION TIME	25-35 seconds
MAXIMUM RANGE	325 yards
MUZZLE VELOCITY	180 feet per second
CALIBER	1½ (38mm)
BODY MATERIAL	Aluminum
MANUFACTURER	Federal Laboratories, Inc.

OPERATION Open the gas riot gun and insert the shell. Close the gun. Hold the gun firmly against the shoulder and fire like a shot gun. The Federal Gas Riot Gun is equipped with a peep sight for use at 50 yard range. This sight is on top of the breech lock. Apertures for 75 and 100 yard range are located on a leaf sight which must be erected before firing at these ranges. This munition can be fired on both 37 and 38mm weapons.

When the gun is fired the projectile is propelled from the gun and the delay is ignited. As the projectile leaves the gun, 3 fins, or vanes, spring into position. These fins, plus the stabilizer weight in the nose of the projectile enable this projectile to be fired with considerable accuracy. Approximately three (3) seconds after the projectile leaves the gun this delay ignites the agent charge. Active agent and smoke will then come out of the exit ports. The discharge will last for about 30 seconds. There will be no explosion or fragmentation of the projectile body. This projectile will penetrate windows, door panels and light structures including 1 inch pine boards and ½ inch plywood.

PROJECTILE, PYROTECHNIC



FEDERAL SPEDEHEAT PROJECTILE

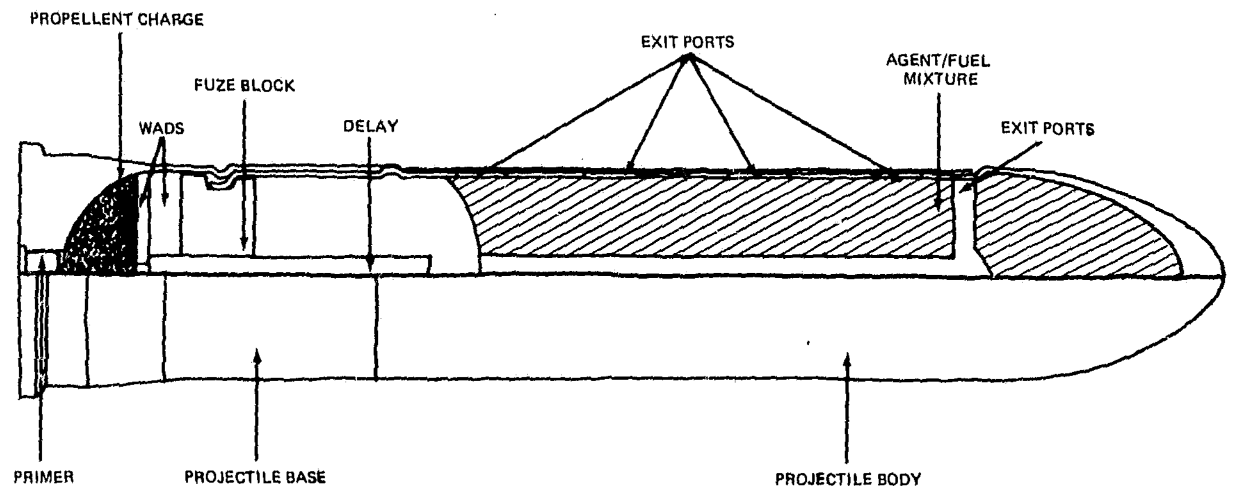
	CN	CS
DISPERSION	PYROTECHNIC	
TOTAL WEIGHT	10 ounces	10 ounces
FILLER WEIGHT	142 grams	140 grams
ACTIVE AGENT	42 grams	42 grams
OTHER	100 grams	98 grams
CATALOG NUMBER	No. 206	No. 560
CATALOG PRICE (1/69)	$ 9.40	$ 9.40
COLOR	Red	Blue

DELAY TIME	3 seconds
AGENT EMISSION TIME	25-35 seconds
MAXIMUM RANGE	150 yards
MUZZLE VELOCITY	225 feet per second
CALIBER	1½ (38mm)
BODY MATERIAL	Aluminum
MANUFACTURER	Federal Laboratories, Inc.

OPERATION Open the gas riot gun and insert the shell. Close the gun. Hold the gun firmly against the shoulder and fire like a shot gun. This munition can be fired in both 37 and 38mm weapons.

At maximum elevation the shell will hit the ground at about 150 yards. Shorter ranges are secured by bouncing the shell along the ground or by firing at very high elevation. When the gun is fired the projectile is propelled from the gun and the delay is ignited. Approximately three (3) seconds later the delay ignites the agent charge. Active agent and smoke will then come out of the exit ports. The discharge will last for about 30 seconds. There will be no explosion or fragmentation of the projectile body.

PROJECTILE, PYROTECHNIC



FEDERAL SPEDEHEAT PROJECTILE (SHORT RANGE)

	CN	CS
DISPERSION PYROTECHNIC		
TOTAL WEIGHT	10.5 ounces	10.5 ounces
FILLER WEIGHT	145 grams	140 grams
ACTIVE AGENT	42 grams	42 grams
OTHER	103 grams	98 grams
CATALOG NUMBER	No. 219	No. 570
CATALOG PRICE (1/69)	$ 9.40	$ 9.40
COLOR	Red	Blue

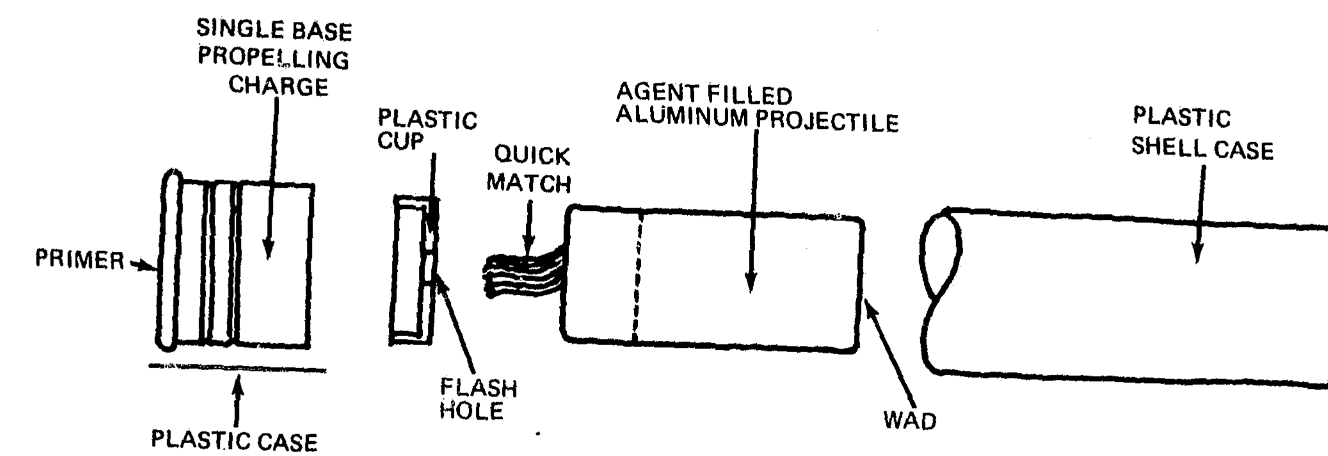
DELAY TIME	3 seconds
AGENT EMISSION TIME	25-35 seconds
MAXIMUM RANGE	90 yards
MUZZLE VELOCITY	140 feet per second
CALIBER	1½ (38mm)
BODY MATERIAL	Aluminum
MANUFACTURER	Federal Laboratories, Inc.

OPERATION Open the gas riot gun and insert the shell. Close the gun. Hold the gun firmly against the shoulder and fire like a shot gun. This munition can be fired in both 37 and 38mm weapons.

At 37.5° elevation the shell will hit the ground at about 90 yards. Shorter ranges are secured by bouncing the shell along the ground or by firing at very high elevation. When the gun is fired the projectile is propelled from the gun and the delay is ignited. Approximately three (3) seconds later the delay ignites the agent charge. Active agent and smoke will then come out of the exit ports. The discharge will last for about 30 seconds. There will be no explosion or fragmentation of the projectile body.

This munition is identical to the SPEDEHEAT 206/560 rounds except for reduced propelling charge.

PROJECTILE, PYROTECHNIC



PENGUIN LONG RANGE CARTRIDGE

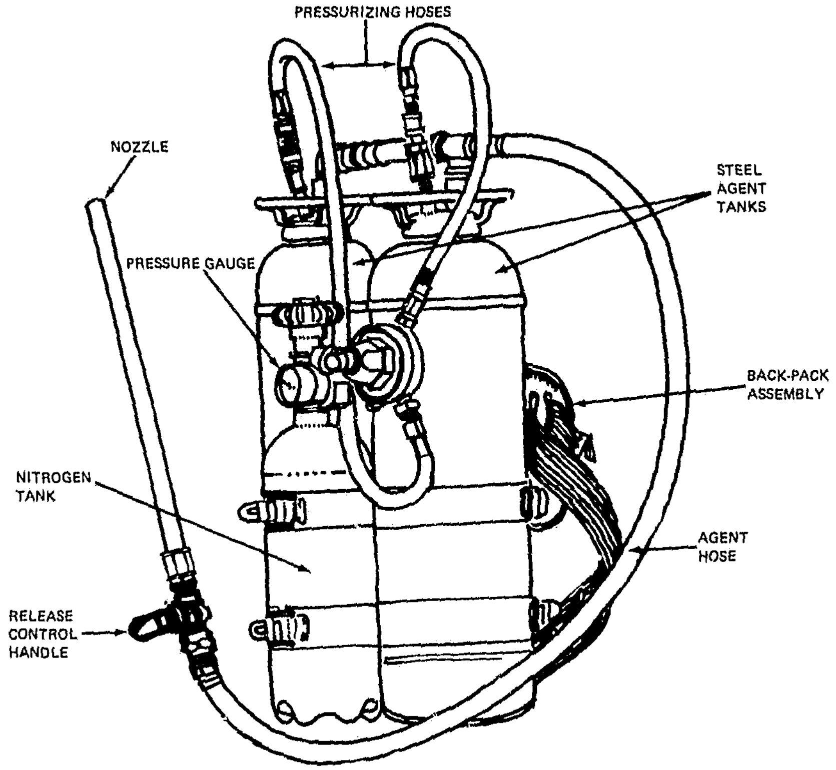
	CN	CS
DISPERSION PYROTECHNIC		
FILLER WEIGHT	1.5 grams	
ACTIVE AGENT	0.6 grams	NR
OTHER	0.9 grams	NR
CATALOG NUMBER	GSA-12	NR
CATALOG PRICE (1/69)	$12.50 per box of 5	GSA-12(CS)
COLOR	Grey Shell	NR
		NR

FUZE TIME	Instantaneous Ignition
AGENT EMISSION TIME	20 to 30 seconds
MAXIMUM RANGE	250 yards
MUZZLE VELOCITY	880 feet per second (estimated)
CALIBER	12 gauge
BODY MATERIAL	Aluminum projectile, Plastic Shell Case
MANUFACTURER	Penguin Industries, Inc.

OPERATION The Long-Range Cartridge is loaded and fired in any standard 12 gauge riot shotgun in the normal manner. The firing pin strikes the primer which ignites the propelling charge and the projectile. The 1-1/2 inch long aluminum projectile is expelled from the bore of the weapon at a low velocity with a relatively accurate projection up to 100 yards.

When fired, the primer and propellent charge ignites the fuel agent mixture which burns for about 20-30 seconds. The projectile does not fragment.

DISPERSER, EXPLUSION



B & H ENTERPRISES PTG-100 AND PTG-200

DISPERSION	EXPULSION			
FORMULATION (s)		Micropulverized CS or CN		
OUTPUT		Variable, maximum 2.6 pounds per second		
CAPACITY		PTG 100 5 pounds/PTG 200 10 pounds		
PRESSURIZATION	Dry Nitrogen			
Tank Capacity		22,000 pounds per square inch		
Consumption		Discharges 3 tanks of agent		
Discharge		50 pounds per square inch		
WEIGHT LOADED				
PTG-100	37 pounds			
PTG-200	46 pounds			
HEIGHT	28 inches	**WIDTH**	**PTG-100**	13 inches
			PTG-200	16 inches
CATALOG PRICE (1/69)		PTG-100	$249.00	
		PTG-200	$325.00	
SOURCE		B & H Enterprises, Inc.		

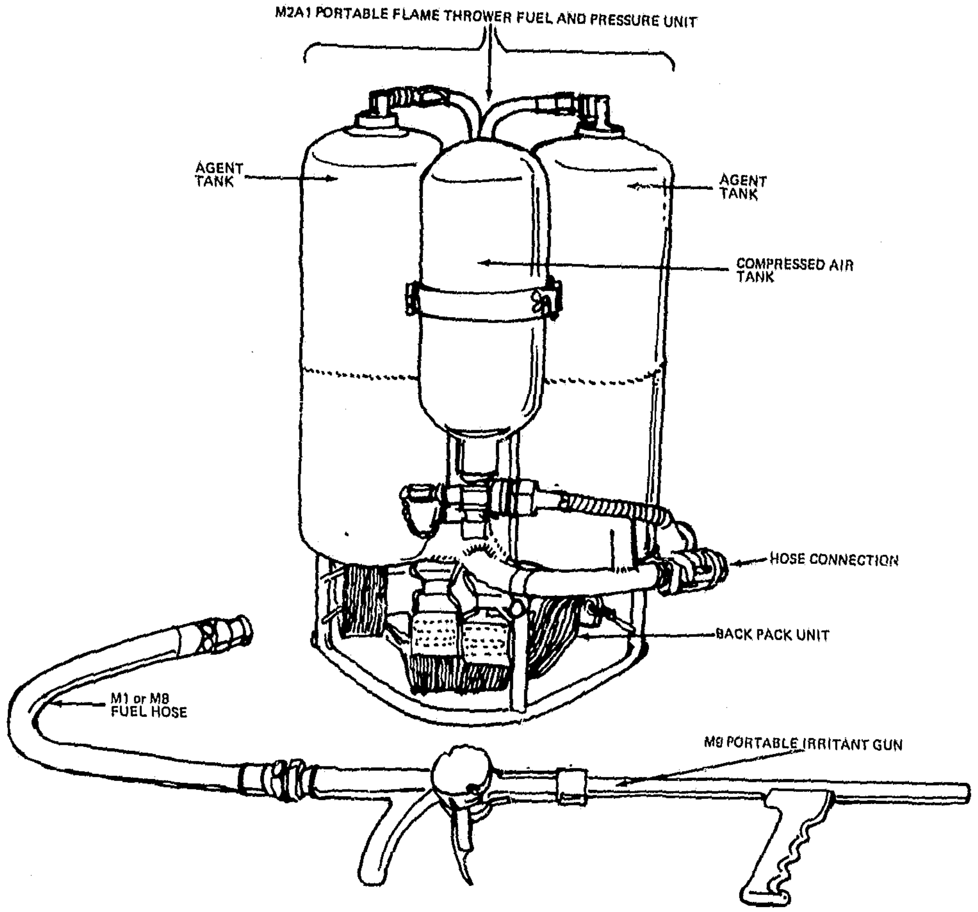
OPERATION PTG-100 and PTG-200 units are identical in loading and operation. PTG-200 units simply carry a double chemical agent supply. These units employ dry nitrogen pressure to expel micropulverized chemical agents for distances exceeding 75 feet in a still air.

The unit is designed to be reloaded in the field without tools and agent formulations are available in stainless steel containers to facilitate this operation.

Agent is released in short bursts utilizing a trigger located on the discharge hose nozzle.

The unit illustrated above is the double tank PTG-200.

DISPERSER, EXPULSION

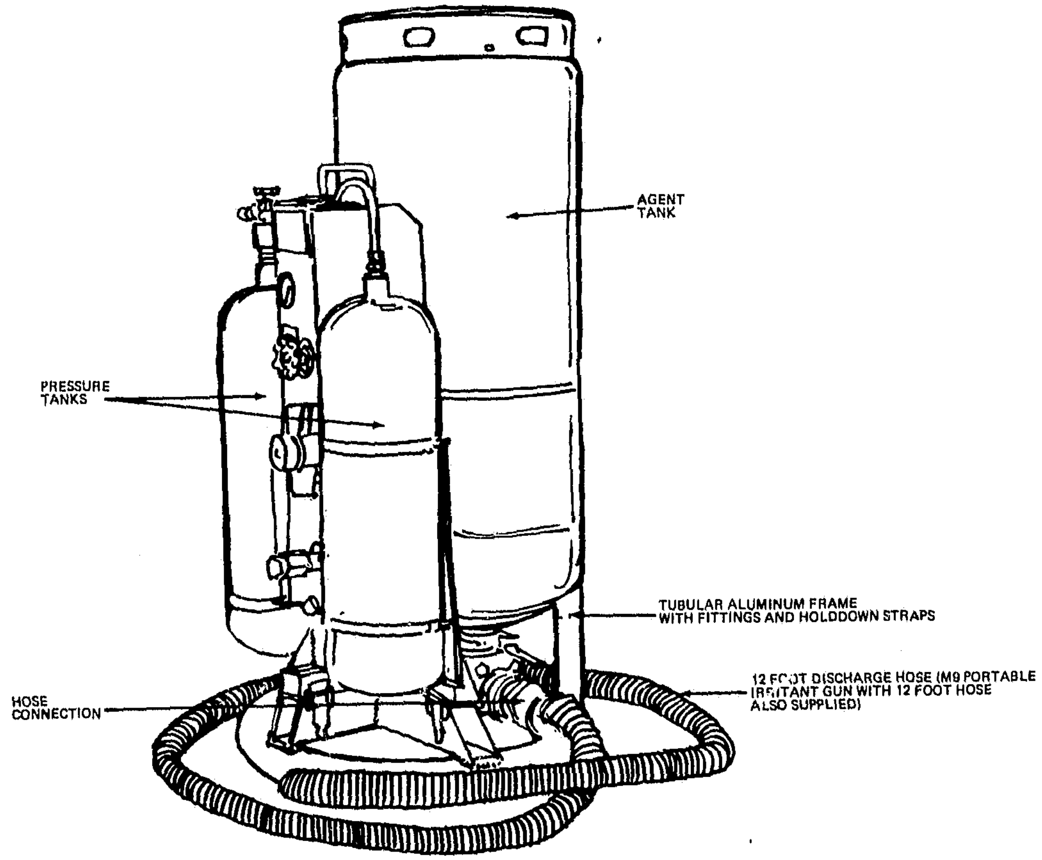


MILITARY DISPERSER, PORTABLE, RIOT CONTROL AGENT, M3

DISPERSION	EXPULSION		
FORMULATION (s)		Micropulverized C S (CS-1)	
OUTPUT		Variable, maximum .32 pounds per second	
CAPACITY		2 tanks, 4 pounds per tank	
PRESSURIZATION		Compressed Air	
Tank Capacity		2000 psi	
Consumption		Discharges 2 tanks of agent	
Discharge		70 pounds per square inch	
WEIGHT LOADED		55 pounds	
HEIGHT	27 inches	**WIDTH**	20 inches
SOURCE		Military, may be loaned to civilian police agencies under emergency conditions.	

OPERATION The M3 Dispenser employs compressed air to expel micropulverized chemical agents for distances exceeding 50 feet in still air. Generally, the distances of the agent release point or line from the target area will range from a minimum of 50 feet to as far as several hundred feet depending on wind velocity. In a wind of about 7-1/2 miles per hour the M3 can disseminate an effective concentration over an area from 45 to 75 feet in width to a downwind distance up to about 600 feet.

The M9 Portable Irritant Gun permits agent release in short bursts or in one continuous discharge. The unit may be reloaded in the field and the air tank recharged if compressed air is available.



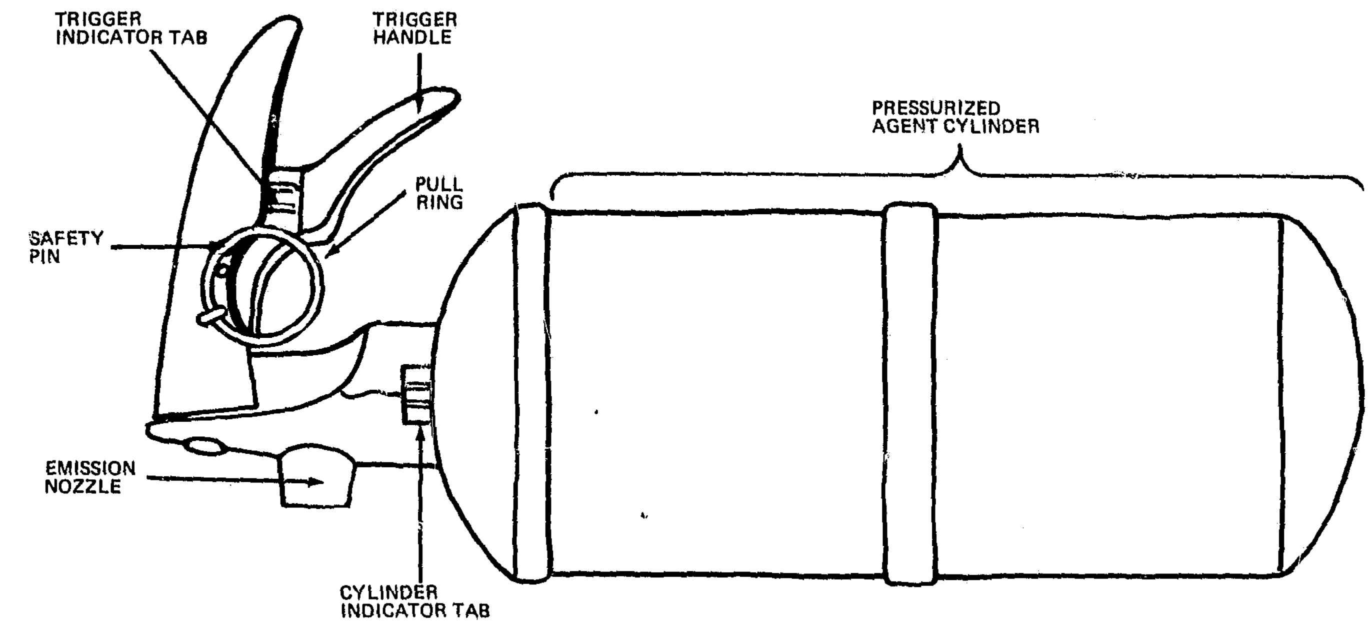
MILITARY DISPERSER, RIOT CONTROL AGENT, HELICOPTER OR VEHICLE MOUNTED, M5

DISPERSION	EXPULSION
FORMULATION (s)	Micropulverized CS (CS-1)
OUTPUT	Variable, 25 pounds per minute
CAPACITY	50 pounds
PRESSURIZATION	Compressed Air
Tank Capacity	2000 pounds per square inch
Consumption	Discharges one 50 pound tank of agent
Discharge	45 pounds per square inch
WEIGHT LOADED	210 pounds
HEIGHT 4 feet	**WIDTH** 2-1/2 feet
SOURCE	Military, may be loaned to civilian police agencies under emergency conditions.

OPERATION The M5 Dispenser utilizes compressed air to force powdered riot control agent into the atmosphere from low-flying aircraft or moving ground vehicles.

When the M9 Gun Group is employed, up to 50 pounds of micropulverized CS can be dispersed in approximately 2 minutes. A helicopter flying at about 66 miles an hour can disseminate an effective concentration of frontage varying from 4,500 feet to 7,500 feet and, in wind speed of about 22 miles per hour, the effective downwind coverage can be about 1,500 feet.

When the M5 is used to disseminate chemical agent from a helicopter the flight crew should be masked to avoid the circulation of agent produced by the rotor wash.



PENGUIN CROWD DISPERSER CND-1

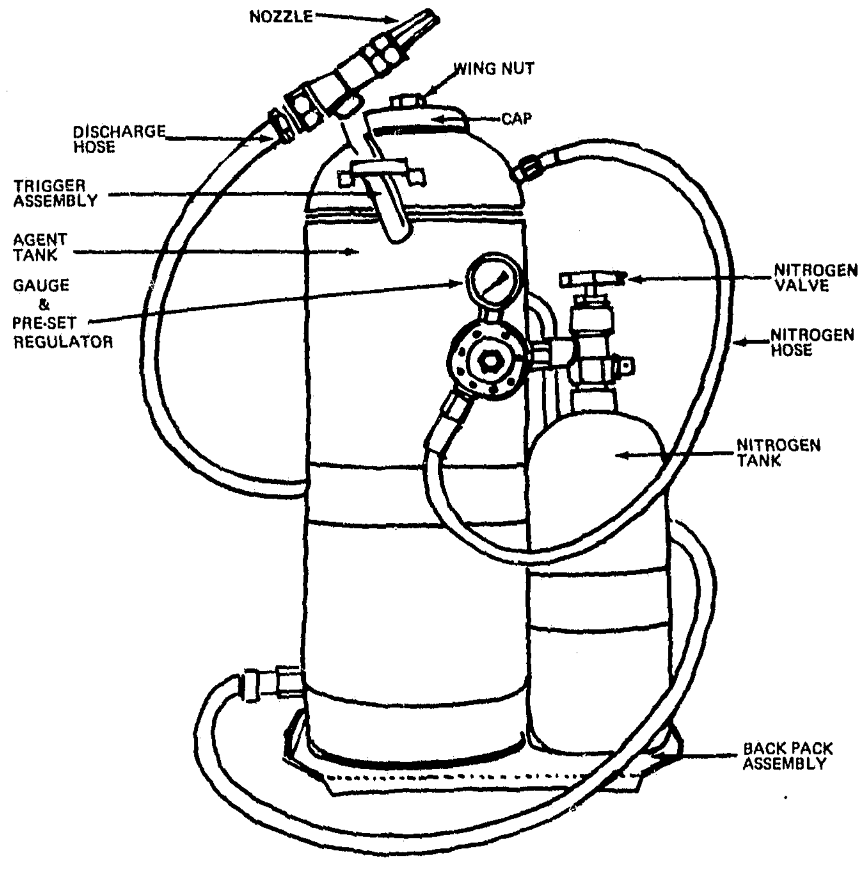
DISPERSION	EXPULSION
FORMULATION (s)	CN/X5
OUTPUT	Variable, 1/32 pound (1/2 ounce) per second
CAPACITY	5 ounces
PRESSURIZATION	Dry Nitrogen
Tank Pressure	215 pounds per square inch
Consumption	Discharges one 81 cubic inch tank
WEIGHT LOADED	2-1/2 pounds
HEIGHT 12-1/2 inches	**DIAMETER** 3-3/4 inches
CATALOG PRICE (1/69)	$32.00
SOURCE	Penguin Industries, Inc.

OPERATION The Penguin Crowd Dispenser is a hand-held dispenser that employs dry nitrogen to project micropulverized chemical agent into the atmosphere. The Dispenser has a range of from 15 feet to 40 feet in still air with a spread of about 15 feet, and a down wind range of about 100 yards, depending upon prevailing wind conditions.

The pressurized dry nitrogen and chemical agent are both contained in a single reservoir that can be connected to the trigger assembly under field conditions.

A canvas pouch is provided to carry an assembled Dispenser and one extra disposable reservoir.

DISPERSER, EXPULSION



Tabor PTG-3 and PTG-6

DISPERSION EXPULSION

FORMULATION (s) Micropulverized CS or CN
OUTPUT Variable, maximum 6 pounds per minute
CAPACITY PTG-3 8 pounds/PTG-6 16 pounds

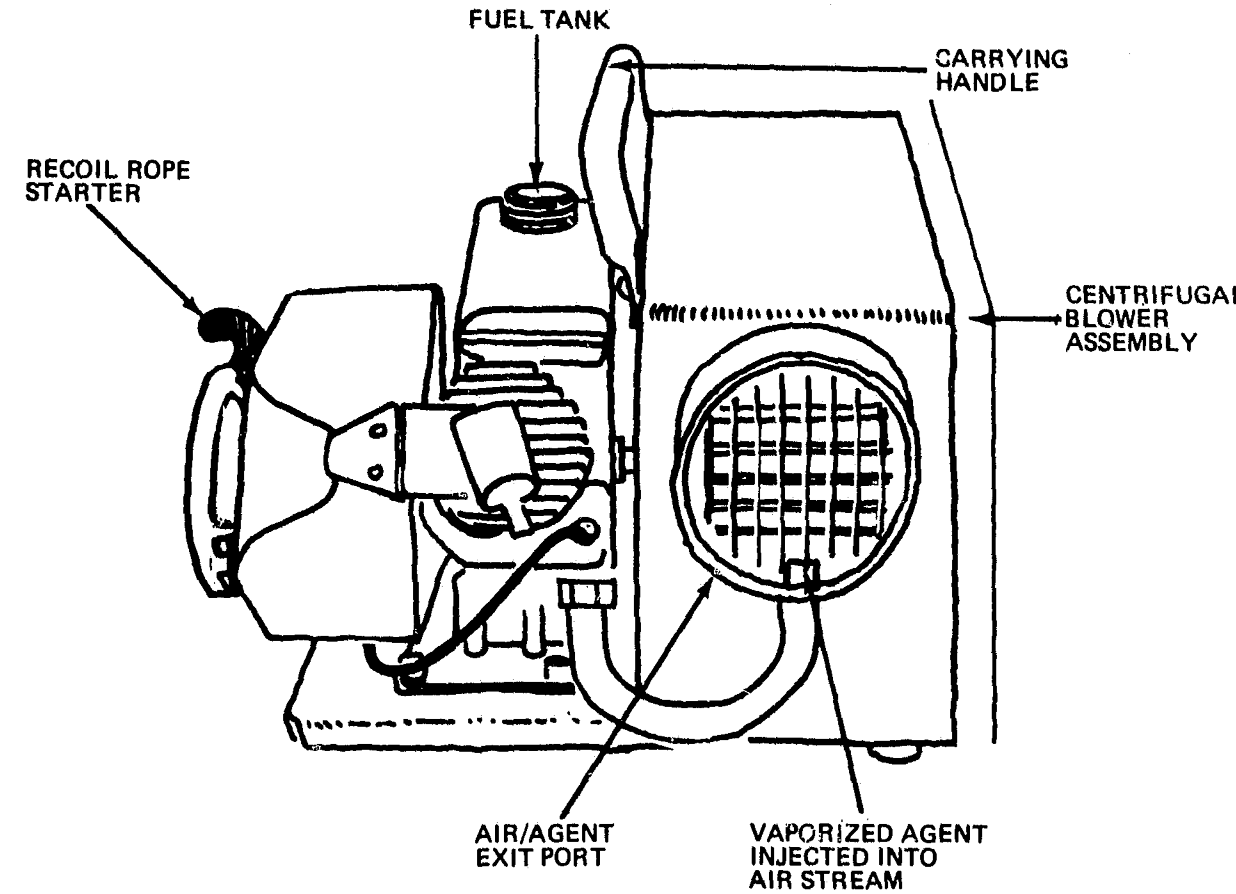
PRESSURIZATION Dry Nitrogen
Tank Capacity 21,000 to 23,000 p.s.i.
Consumption Discharges 4 tanks of agent
Discharge 40 pounds per square inch
WEIGHT LOADED
PTG-3 35 pounds
PTG-6 55 pounds
HEIGHT 24 inches **WIDTH** 14 inches
CATALOG PRICE (1/69) PTG-3 $245.00
PTG-6 $295.00
SOURCE P.M. Tabor Company

OPERATION PTG-3 and PTG-6 units are identical in loading and operation. PTG-6 units simply carry a double chemical agent supply. These units employ dry nitrogen pressure to expel micropulverized chemical agents for distances exceeding 50 feet in a still air.

The unit is designed to be reloaded in the field without tools and agent formulations are available in plastic containers to facilitate this operation.

Agent is released in short bursts utilizing a trigger located on the discharge hose nozzle.

DISPERSER, FOG



FEDERAL JET-FOGGER

DISPERSION FOG

FORMULATION (s) CS Fog, CN Fog, Inert Fog
OUTPUT NR gallons per hour
CAPACITY 1 qt cannisters (8-10 min)
FUEL Gasoline/Oil Mixture
Tank Capacity 1/4 gallons (45 min)
Consumption 3/8 gallons per hour

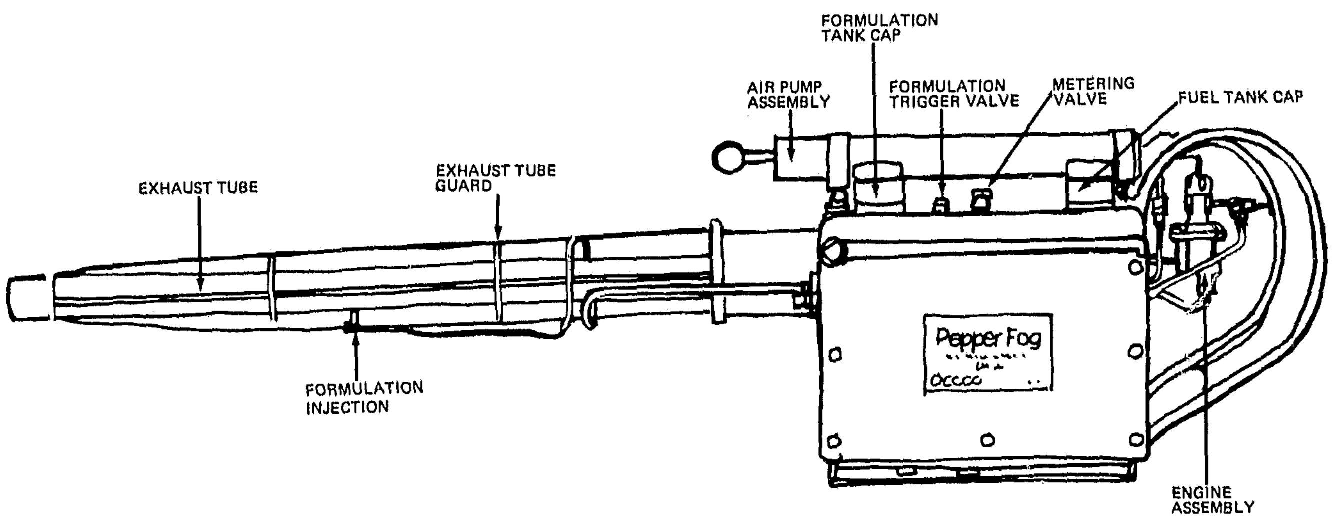
WEIGHT
Empty 33 pounds, 13 ounces
Filled 37 pounds, 4 ounces
LENGTH 18 inches **HEIGHT** 15.5 inches **WIDTH** 15 inches

CATALOG PRICE (1/69) $375
SOURCE Federal Laboratories, Inc.

OPERATION The Federal Jet-Fogger employs a heavy duty 2-cycle industrial type engine as a heat source. The engine is also coupled to a centrifugal blower. The fog formulation is sprayed into the exhaust manifold where it vaporizes. The vapor is directed to the mouth of the blower where the cool blast condenses it into a fog and the resulting air/agent mixture is expelled from the generator. Particle size ranges from 0.5 to 100 Microns. Agent concentration may be varied by rotating the cannister in its mounting on the dispenser.

This unit is suitable for vehicle or stationary mounting.

DISPERSER, FOG



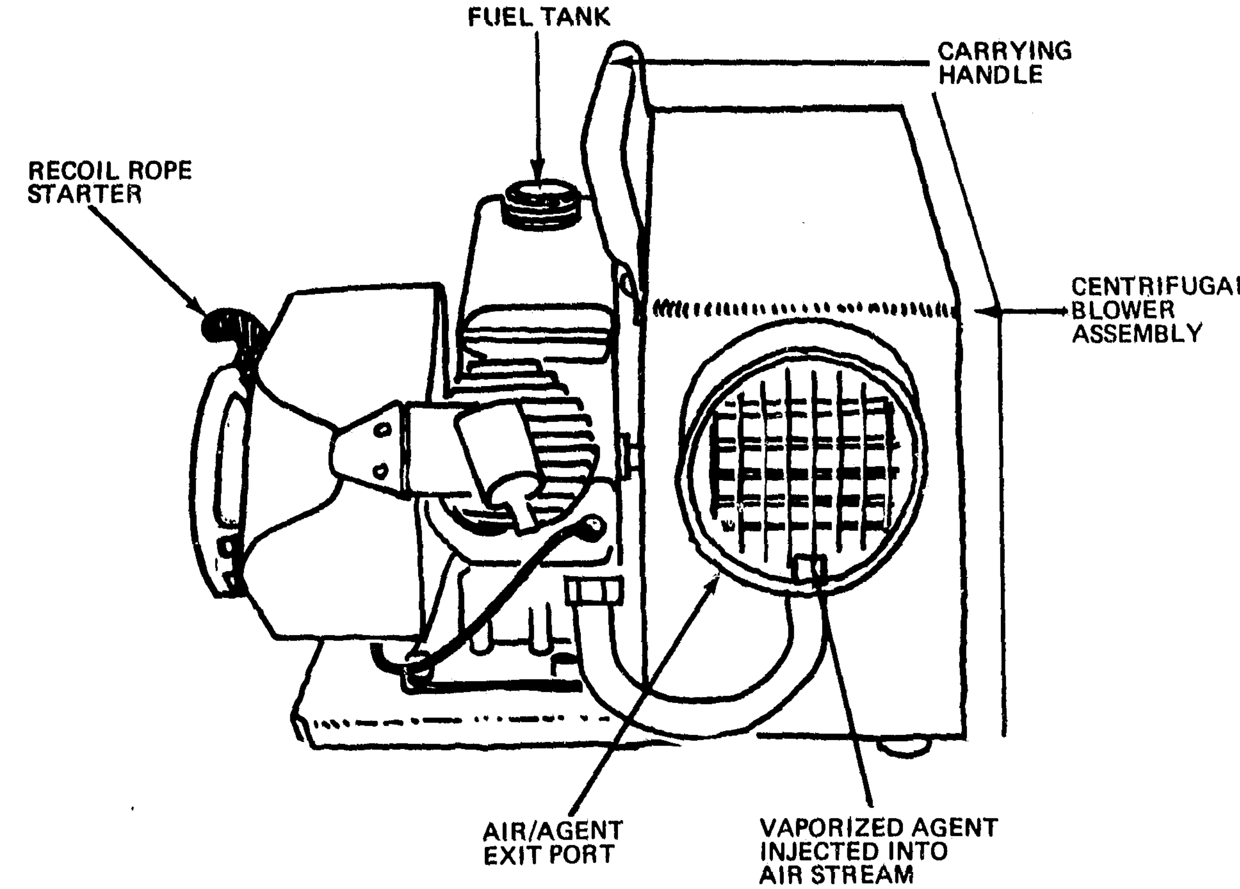
GOEC MK-XII AND MK-XII-A PEPPER FOG

DISPERSION	FOG				
FORMULATION (s)		CS Fog, CN Fog, Inert Fog			
OUTPUT		0-7 gallons per hour			
CAPACITY		1 gallon (10-20 min)			
FUEL		Gasoline			
Tank Capacity		1/5 gallon (45 min)			
Consumption		1/4 gallon per hour			
WEIGHT					
Empty		19 pounds			
Filled		27 pounds			
LENGTH	46 inches	**HEIGHT** 13-1/4 inches		**WIDTH**	9-5/8 inches
CATALOG PRICE (1/69)		$395			
SOURCE		General Ordnance Equipment Corporation			

OPERATION The Mark XII-A Generator employs the resonant pulse jet principle to generate hot gases flowing at high velocity. The high velocity gases atomize the liquid formulation instantly so that it is vaporized and condensed so rapidly that thermal breakdown of the irritant chemical is non-existant or negligible. The fog particle size is controllable from 1 - 50 Microns and beyond, with smaller particle sizes associated with lower formulation flow rates. Operators will learn, through experience, the most effective rate of flow and particle size for various tactical situations.

Specifications are for the newer MK-XII-A which is shorter in overall length and slightly modified from the original MK-XII shown in the illustration.

DISPERSER, FOG



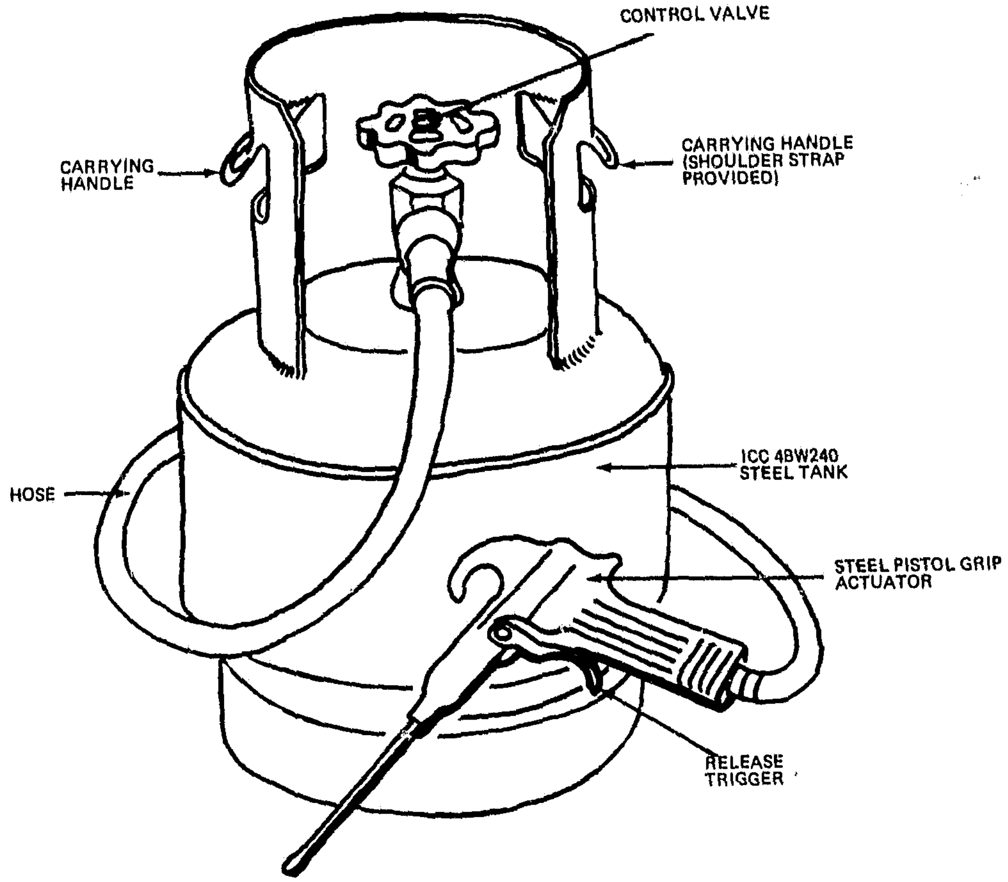
GOEC MK-17 Pepper Fog

DISPERSION	FOG				
FORMULATION (s)		CS Fog, CN Fog, Inert Fog			
OUTPUT		5 gallons per hour			
CAPACITY		2 - 1 quart cartridges			
FUEL		Gasoline/Oil Mixture			
Tank Capacity		3/4 qt. (45 min)			
Consumption		1/4 gallon per hour			
WEIGHT					
Empty	31 pounds				
Filled	36 pounds				
LENGTH	18 inches	**HEIGHT**	12 inches	**WIDTH**	15 inches
CATALOG PRICE (1/69)		$395			
SOURCE		General Ordnance Equipment Corporation			

OPERATION The GOEC MK-17 employs a conventional 2-cycle industrial engine as a heat source. The engine is also coupled to a centrifugal blower. The fog formulation is sprayed into the exhaust manifold where it is vaporized. The vapor is directed to the mouth of the blower where the cool blast condenses it into a fog and the resulting air agent mixture is expelled from the generator. Particle size ranges from 0.5 to 100 microns.

This unit is suitable for vehicle or stationary mounting.

DISPERSER, LIQUID



MIDDLE WEST MARKETING 5000cc CHEMICAL WEAPON

DISPERSION LIQUID	
FORMULATION (s)	Liquid CN (.9% CN in solution with synergistic carriers)
OUTPUT	Variable, 70 grams per second
CAPACITY	5 quarts
PRESSURIZATION	Nitrogen
Tank Capacity	1,000 pounds per square inch
Consumption	Discharges 5 quarts
Discharge	150 pounds per square inch
WEIGHT LOADED	28 pounds
HEIGHT 13 inches	**DIAMETER** 8-1/2 inches
CATALOG PRICE (1/69)	$125.00
SOURCE	Middle West Marketing Company

OPERATION The 5000 c.c. Chemical Weapon employs nitrogen to expel a liquid .9% CN formulation for distances up to 35 or 40 feet in still air. The formulation remains in the liquid state and consequently can be directed toward specific targets or small groups of persons in a larger crowd.

The irritant formulation, which is the same as that employed in the aerosol irritant projector produced by the same manufacturer, may be released as a continuous stream or in a series of up to 70 one-second bursts.

The canister cannot be refilled in the field.

CONTINUED

2 OF 3

APPENDIX D

Chemical Agent Bibliography

SELECTED CHEMICAL AGENT DOCUMENTS

Books, articles, and reports designated with a check (√) mark are recommended as basic reading for chemical agent officers as discussed in Chapter One.

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APPENDIX E

Testing Aerosol Irritant Projector Formulations

There are, at the present time, no completely satisfactory standard tests for aerosol irritant projector formulations. This is unfortunate and results as much from a lack of concept as from an absence of technology. Once the purpose of the projector is agreed upon, formulation criteria can be established and supporting test procedures can be evolved without major difficulty by either public or private laboratories.

This appendix will suggest a rationale for the chemical agent projector and will recommend a series of interim tests that can be applied until more adequate evaluation procedures are developed. It should be emphasized at the outset that this discussion relates only to formulation, other important physical and performance standards are outlined in Chapter Five.

DEFINITION: Aerosol irritant projectors are hand-held and activated non-lethal weapons designed to launch an aerosol liquid chemical formulation into the atmosphere.

PURPOSE: Projectors are used by law enforcement personnel to deliver irritant chemicals of sufficient strength to temporarily incapacitate persons engaged in unlawful acts of violence against other persons or the police. In rare instances the projector may be employed to prevent an individual from committing an act of violence against himself.

DISCUSSION: Chemical projectors are designed, then, to inflict irritation and discomfort to the degree necessary to achieve their purpose – temporary incapacitation of violent persons. They are not intended or recommended for use against:

a. Persons already incapacitated

b. Persons incapable of seriously violent activity.

c. Persons passively engaged in unlawful conduct.

d. Any person whose immediate and actual behavior does not present a clear and present threat of physical injury to another human being.

Projectors should not be used punitively, indiscriminately, or promiscuously. They are *not* riot control devices to be used against large crowds or even small groups unless the behavior of such groups meets the violence criteria. (This is not to suggest that there is anything wrong with the use of liquid riot control agents, but only that their performance characteristics might differ substantially from those of the standard aerosol irritant projector under discussion.)

To argue that some law enforcement personnel or agencies do not employ projectors as recommended above is to confuse an education and training problem with a technological one. The only way to prevent misuse of a weapon is to make it harmless. The potential for projector misuse is relevant to formulation selection only to the extent that between equally effective formulations the product of choice would be that which could tolerate the widest range of misuse without causing undesirable results.

CRITERIA: An ideal aerosol irritant projector formulation will instantly incapacitate a violent person without permanent injury and with the least possible temporary trauma.

DISCUSSION: What is required is a formulation that produces rapid and temporary incapacitation. It is essential to understand that rapid incapacitation is at least as important as the transient nature of the effects produced. In fact, if the projector does not function with a high probability of stopping violent attackers quickly, the device is of little value to police regardless of the other characteristics of the formulation.

The need for rapid action arises, of course, from the circumstances under which projectors are employed by the police. Because of these same considerations the formulation should produce its incapacitating effects without the necessity of a direct burst of liquid droplets into the eyes. Whether incapacitation results from the action of the formulation on the skin, the lacrimating effects of the vapor, or a combination of both, action must be almost instantaneous.

In addition to being effective in terms of rapid incapacitation, the formulation should offer a very low risk of permanent injury. Considering the variations of human physiology, it is doubtful that all risk can ever be eliminated from those situations in which chemical weapons are employed. On the other hand, such risk should be kept at the lowest possible level.

Temporary injury, severity and duration of pain, and discomfort should be held to the lowest level consistent with the effectiveness of the weapon.

EVALUATION: Any adequate evaluation of projector formulations would require a series of laboratory tests and field experiments that would include at least the assessment of:

- √ Injury Potential – eyes, skin, and systemic toxicity.
- √ Effectiveness – speed and degree of incapacitation.
- √ Discomfort Level – severity and duration of pain or irritation.

TEST RECOMMENDATIONS

A. INJURY POTENTIAL

In the course of the development and marketing of aerosol irritant projectors it has become customary to subject formulations to the eye irritant test required for certain products under the Federal Hazardous Substances Act. (FHSA).

DEFINITIONS AND INTERPRETATIONS

§ 191.1 Definitions.

(a) *Act.* "Act" as used in this part means the Federal Hazardous Substances Act.

(b) *Commissioner.* "Commissioner" means the Commissioner of Food and Drugs, Food and Drug Administration, Department of Health, Education, and Welfare.

(c) *Hazardous substances intended or packaged in a form suitable for use in the household.* "Hazardous substances intended or packaged in a form suitable for use in the household" means any hazardous substance, whether or not packaged, that under any customary or reasonably foreseeable condition of purchase, storage, or use may be brought into or around a house, apartment, or other place where people dwell, or in or around any related building or shed, including but not limited to a garage, carport, barn, or storage shed. The term includes such articles as polishes or cleaners designed primarily for professional use but that are available in retail stores such as hobby shops for non-professional use. Also included are such items as anti-freeze and radiator cleaners that although principally for car use may be stored in or around dwelling places. The term does not include industrial supplies that might be taken into a home by a serviceman. An article labeled as and marketed solely for industrial use does not become subject to this act because of the possibility that an industrial worker may misappropriate a supply for his own use. Size of unit or container is not the only index of whether the article is suitable for use in or around the household. The test shall be whether under any reasonably foreseeable condition of purchase, storage, or use the article may be found in or around a dwelling.

Whatever misunderstanding may have existed earlier, it is now clear that projectors intended only for police use are not currently considered subject to the provisions of the Federal Hazardous Substance Act.

Some of these articles (aerosol irritant projectors) are subject to the requirements of the Federal Hazardous Substances Act because they are offered to the public and do in fact find their way into the home. Others are distributed only to police officers; these are not subject to control under the Federal Hazardous Substances Act because they are not household articles.

Tear gas devices distributed to the public have found rather extensive use in two areas:

1. For repelling vicious animals.
2. For self-protection against would-be attackers.

Tear gas devices sold for warding off vicious animals are subject to registration with the U. S. Department of Agriculture under the Federal Insecticide, Fungicide and Rodenticide Act. Products subject to that Act are specifically exempt from the provisions of the Federal Hazardous Substances Act. The tear gas devices intended for self-protection from would-be attackers, however, are subject to the Federal Hazardous Substances Act.[1]

[1] Statement by Herbert L. Ley, Jr., M.D., Commissioner of Food and Drugs, Public Health Service, U.S. Department of Health, Education, and Welfare, before the Subcommittee on (the) Consumer, Senate Commerce Committee, 21 May, 1969.

A frequent criticism of the use of the Federal Hazardous Substances Act as an implied endorsement of projector formulations was that the eye irritant test was applied while the FHSA skin irritant test and other relevant provisions were generally ignored.

§ 191.1 Definitions

(g) *Irritants.* The term "irritant" includes "primary irritant to the skin" as well as substances irritant to the eye or to mucous membranes.

(2) The term "primary irritant" means a substance that is not corrosive and that the available data of human experience indicate is a primary irritant; or which results in an empirical score of five or more when tested by the method described in § 191.11.

(3) *Eye irritants.* A substance is an irritant to the eye if the available data on human experience indicate that it is an irritant to the eye, or if a positive test result is obtained when the substance is tested by the method described in § 191.12.

§ 191.7 Products requiring special labeling under section 3(b) of the act.

(a) Human experience as reported in the scientific literature and to the Poison Control Centers and the National Clearing House for Poison Control Centers, together with opinions of informed medical experts, establishes that the following substances are hazardous:

(1) Carbon tetrachloride and mixtures containing it.

(2) Diethylene glycol including mixtures containing 10 percent or more by weight of diethylene glycol.

(3) Ethylene glycol including mixtures containing 10 percent or more by weight of ethylene glycol.

(4) Products containing 5 percent or more, by weight, of benzene (also known as benzol) and products containing 10 percent or more, by weight, of toluene (also known as toluol), xylene (also known as xylol), or petroleum distillates such as kerosine, mineral seal oil, naphtha, gasoline, mineral spirits, stoddard solvent, and related petroleum distillates.

(5) Methyl alcohol including mixtures containing 4 percent or more by weight of methyl alcohol.

Such criticism is valid to the extent that the application of the standards of § 191.7 would have eliminated some dangerous formulations that included carbon tetrachloride and a high volume, by weight, of kerosene or even methyl alcohol in the carrier/solvent component. It is also true that reference to a single FHSA standard, if used to suggest product approval or endorsement, is a questionable practice. The primary skin irritation test was avoided simply because it is unlikely that any of the present formulations could fully meet its requirements.

1. Eye Irritation

On the other hand, the FHSA eye irritant test, when properly conducted, has proved to be a valuable screening test and it is recommended as an interim test for police aerosol irritant formulations.

EYE IRRITATION TEST

TESTING PROCEDURES FOR HAZARDOUS SUBSTANCES

§ 191.12 Test for eye irritants.

(a) (1) Six albino rabbits are used for each test substance. Animal facilities for such procedures shall be so designed and maintained as to exclude sawdust, wood chips, or other extraneous materials that might produce eye irritation. Both eyes of each animal in the test group shall be examined before testing, and only those animals without eye defects or irritation shall be used. The animal is held firmly but gently until quiet. The test material is placed in one eye of each animal by gently pulling the lower lid away from the eyeball to form a cup into which the test substance is dropped. The lids are then gently held together for one second and the animal is released. The other eye, remaining untreated, serves as control. For testing liquids, 0.1 milliliter is used. For solids or pastes, 100 milligrams of the test substance is used, except that for substances in flake, granule, powder, or other particulate form the amount that has a volume of 0.1 milliliter (after compacting as much as possible without crushing or altering the individual particles, such as by tapping the measuring container) shall be used whenever this volume weighs less than 100 milligrams. In such a case, the weight of the 0.1 milliliter test dose should be recorded. The eyes are not washed following instillation of test material except as noted below.

(2) The eyes are examined and the grade of ocular reaction is recorded at 24, 48, and 72 hours. Reading of reactions is facilitated by use of a binocular loupe, hand slit-lamp, or other expert means. After the recording of observation at 24 hours, any or all eyes may be further examined after applying fluorescein. For this optional test, one drop of fluorescein sodium ophthalmic solution U.S.P. or equivalent is dropped directly on the cornea. After flushing out the excess fluorescein with sodium chloride solution U.S.P. or equivalent, injured areas of the cornea appear yellow; this is best visualized in a darkened room under ultraviolet illumination. Any or all eyes may be washed with sodium chloride solution U.S.P. or equivalent after the 24 hour reading.

(b) (1) An animal shall be considered as exhibiting a positive reaction if the test substance produces at any of the readings ulceration of the cornea (other than a fine stippling), or opacity of the cornea (other than a slight dulling of the normal luster), or inflammation of the iris (other than a slight deepening of the folds (or rugae) or a slight circumcorneal injection of the blood vessels), or if such substance produces in the conjunctivae (excluding the cornea and iris) an obvious swelling with partial eversion of the lids or a diffuse crimson-red with individual vessels not easily discernible.

(2) The test shall be considered positive if four or more of the animals in the test group exhibit a positive reaction. If only one animal exhibits a positive reaction, the test shall be regarded as negative. If two or three animals exhibit a positive reaction, the test is repeated using a different group of six animals. The second test shall be considered positive if three or more of the animals exhibit a positive reaction. If only one or two animals in the second test exhibit a positive reaction, the test shall be repeated with a different group of six animals. Should a third test be needed, the substance will be regarded as an irritant if any animal exhibits a positive response.

This test is graded by the scale for scoring ocular lesions illustrated below. Positive values are indicated by a check (√) mark.

SCALE FOR SCORING OCULAR LESIONS*

(1) Cornea

(A) Opacity-degree of density (area most dense taken for reading)

No Opacity	0
Scattered or diffuse area, details of iris clearly visible	1√
Easily discernible translucent areas, details of iris slightly obscured	2
Opalescent areas, no details of iris visible, size of pupil barely discernible	3
Opaque, iris invisible	4

(B) Area of cornea involved

One quarter (or less) but not zero	1
Greater than one quarter, but less than half	2
Greater than half, but less than three quarters	3
Greater than three quarters, up to whole area	4

Score equals A x B x 5 Total maximum= 80

Iris

(A) Values

Normal	0
Folds above normal, congestion, swelling, circumcorneal injection (any or all of these or combination of any thereof) iris still reacting to light (sluggish reaction is positive)	1√
No reaction to light, hemorrhage, gross destruction (any or all of these)	2

Score equals A x 5 Total maximum= 10

(Continued)

SCALE FOR SCORING OCULAR LESIONS (Continued)

Conjunctivae

(A) Redness (refers to palpebral and bulbar conjunctivae excluding cornea and iris)

Vessels normal	0
Vessels definitely injected above normal	1
More diffuse, deeper crimson red, individual vessels not easily discernible	2√
Diffuse beefy red	3

(B) Chemosis

No swelling	0
Any swelling above normal (includes nictitating membrane)	1
Obvious swelling with partial eversion of lids	2√
Swelling with lids about half closed	3
Swelling with lids about half closed to completely closed	4

Score equals (A+ B) x 2 Total maximum= 14

The maximum total score is the sum of all scores obtained for the cornea, iris, and conjunctivae. Total maximum score possible= 104

*Adapted from Lehman, A. J. et al., Appraisal of the Safety of Chemicals in Foods, Drugs, and Cosmetics, Assoc. Food and Drug Officials of the U. S., Austin, Texas, 1959.

2. Skin Irritation

While the FHSA § 191.11 test for primary skin irritation is too stringent for the evaluation of irritant formulations, it can be modified to serve as a meaningful interim skin test. The modified test as outlined below is recommended for police aerosol irritant formulations.

SKIN IRRITATION TEST

Primary irritation to the skin is measured by a patch-test technique on the abraded and intact skin of the albino rabbit, clipped free of hair. A minimum of six subjects are used in abraded and intact skin tests. Introduce under a square patch such as surgical gauze measuring 1 inch x 1 inch, two single layers thick, 0.5 milliliter (in case of liquids) or 0.5 gram (in case of solids and semisolids) of the test substance. Dissolve solids in an appropriate solvent and apply the solution as for liquids. The animals are immobilized with patches secured in place by adhesive tape.

An equal number of exposures are made on areas of skin that have been previously abraded. The abrasions are minor incisions through the stratum corneum, but not sufficiently deep to disturb the derma or to produce bleeding. After 24 hours of exposure, the patches are removed and the resulting reactions are evaluated on the basis of the designated values in the following table:

Evaluation of skin reactions	*Value* [1]
Erythema and eschar formation:	
No erythema	0
Very slight erythema (barely perceptible)	1
Well-defined erythema	2
Moderate to severe erythema	3
Severe erythema (beet redness) to slight eschar formation (injuries in depth)	4
Edema formation:	
No edema	0
Very slight edema (barely perceptible)	1
Slight edema (edges of area well defined by definite raising)	2
Moderate edema (raised approximately 1 millimeter)	3
Severe edema (raised more than 1 millimeter and extending beyond the area of exposure)	4

[1] The "value" recorded for each reading is the average value of the six or more animals subject to the test.

Patches are not replaced and readings are again made at the end of a total of 72 hours (48 hours after the first reading), 96 hours, 120 hours, and 240 hours.

Add the values for erythema and eschar formation at each reading for both intact and abraded skin. Similarly, add the values for edema formation at each reading. The total of the twenty values is divided by 10 to give the irritation score.

SKIN IRRITATION TEST (Continued)

Example: (recommended skin irritation test)

	Exposure Time Hours	Exposure Unit Value
Erythema and eschar formation:		
Intact skin	24	2
	72	2
	96	1
	120	1
	240	0
Abraded skin	24	3
	72	3
	96	2
	120	0
	240	0
Sub-total		14
Edema formation		
Intact skin	24	0
	72	1
	96	
	120	
	240	
Abraded skin	24	2
	72	2
	86	1
	120	0
	240	0
Sub-total		7
Total		21
Irritation score is 21 ÷ 10 = 2.1		

The skin irritation test shall be considered positive if four or more of the animals in the test group exhibit a positive reaction at 240 hours. If only one animal in the test group exhibits a positive reaction at 240 hours the test shall be regarded as negative. If two or three animals exhibit a positive reaction at 240 hours the test is repeated using a different group of six animals. The second test shall be considered positive if three or more of the animals exhibit a positive reaction at 240 hours. If only one or two of the animals in the second test exhibit a positive reaction, the test shall be repeated with a different group of six animals. Should a third test be needed, the substance will be regarded as an unacceptable irritant if any animal exhibits a positive response.

A positive response is represented by any value above zero.

The present purpose of the skin irritation test is to screen out formulations that may produce permanent after-effects or systemic toxicity. Once this test procedure has been applied to a wide variety of formulations it may be possible to establish a numerical value cut-off point for acceptability. In the meantime, the product of choice will be that formulation which is effective, negative in the eye test, and which has the lowest skin irritation value.

3. Vapor Toxicity

Underwriter's Laboratories, Inc., has conducted extensive investigations into the life hazards of common refrigerants and has issued reports on their characteristics. Although these tests were *not* conducted on aerosol irritant formulations, they do cover substances that are frequently used as the carrier/solvent component of projector formulations. These data are considered useful as a guide to acute toxicity where persons might be exposed to gross concentrations of vapors in the air for relatively short periods of time. While admittedly not as sophisticated a screening test as might be desirable, the requirement of an Underwriters' toxicity group classification of more than 4 for the major carrier/solvent will eliminate many high-risk formulations.

UNDERWRITER'S LABORATORIES TOXICITY CLASSIFICATION

Group	Definition	Examples
1	Gases or vapors which in concentrations of the order of ½ to 1 percent for durations of exposure of the order of 5 minutes are lethal or produce serious injury.	Sulfur dioxide
2	Gases or vapors which in concentrations of the order of ½ to 1 percent for durations of exposure of the order of ½ hour are lethal or produce serious injury.	Ammonia Methyl Bromide
3	Gases or vapors which in concentrations of the order of 2 to 2½ percent for durations of exposure of the order of 1 hour are lethal or produce serious injury.	Carbon Tetrachloride Chloroform Methyl formate
4	Gases or vapors which in concentrations of the order of 2 to 2½ percent for durations of exposure of the order of 2 hours are lethal or produce serious injury.	Dichlorethylene Methyl chloride Ethyl Bromide
Between 4 & 5	Less toxic than Group 4 but somewhat more toxic than Group 5.	Dichloromonofluoromethane Ethyl Chloride Methylene Chloride Trichlorotrifluoroethane
5	Intermediate between Groups 4 and 6	Azeotropic Mixture of Dichlorodifluoromethane and Unsymmetrical Difluoroethane Azeotropic Mixture of Monochlorodifluoromethane and Monochlorodifluoroethane Butane Carbon Dioxide Ethane Monochlorodifluoromethane Propane Trichloromonofluoroethane
6	Gases or vapors which in concentrations up to at ~~least~~ about 20 percent by volume for durations of exposure of the order of 2 hours do not appear to produce injury.	Dichlorodifluoromethane Dichlorotetrafluroethane Monochloropentafluoroethane

B. EFFECTIVENESS

While it may be possible to develop animal experiments to judge the speed and degree of incapacitation produced by a projector formulation, these characteristics can also be evaluated through simple field tests. These tests should, of course, be conducted with formulations that meet the injury potential standards discussed in A above.

LACRIMATION TEST

Using separate cotton swabs, apply an equal amount of formulation to the cheek, two inches below the center of the eye, of six individuals. Using a standard stop watch, time the interval between application of the formulation and the onset of lacrimation. Score by adding the individual elapsed time periods ~~and dividing~~ by six.

INCAPACITATION TEST

Construct a test range by placing marks on the ground at the distances indicated below.

	A●										B
Ft.	0	1	2	3	4	5	6	7	8	9	10

Testing should be done out of doors on a calm day. Test subject stands on line B with eyes closed. The projector is fired from point A with a one second burst aimed to strike the test subject in the lower face. A standard stop watch is used to measure the time interval between formulation impact and total incapacitation as determined by the subjects inability to perform simple tasks on command.

The test procedure is repeated on six subjects in a manner to preclude each subject from viewing preceding tests. A physician should be present during all tests and aerosol irritant first aid practices should be applied upon incapacitation or as soon as requested by the test subject. In any event, first aid should be applied after 90 seconds have elapsed from the moment of impact.

C. DISCOMFORT LEVEL

When other formulation standards have been met, the final consideration is the severity and duration of pain or irritation. For both humanitarian and practical reasons it is desirable to minimize pain and discomfort. In the normal course of events persons upon whom the projector is used will be taken into custody and their movement restrained by handcuffs. If severe pain persists, resistance is often prolonged and the sympathy of bystanders aroused. In either case, additional police problems may develop.

Unfortunately, the subjective nature of discomfort makes measurement difficult. However, some opinion on this formulation characteristic can be recorded in the process of conducting the effectiveness tests recommended in Section B. A simple scale is used to record subjective impressions of severity:

1. Slight
2. Mild
3. Moderate
4. Severe
5. Extreme

Duration can be measured in minutes from impact of formulation to absence of pain and the six different time values added and divided by six to achieve a total score.

Admittedly, both severity and duration of pain cannot be measured with any degree of accuracy, but at this phase of the screening process less accuracy is required and minor errors can be tolerated.

PROCUREMENT PROCEDURE

For the police administrator, the best possible arrangement would be for a central agency, such as the National Institute of Law Enforcement and Criminal Justice of the Law Enforcement Assistance Administration, to conduct all of the recommended tests on aerosol irritant projector formulations and make these evaluation results available to the police community. Such an evaluation system should be followed up with a continuing quality control inspection program.

In the absence of federal assistance, the department should develop specifications such as those suggested in Chapter 5 and initiate competitive bidding. Projectors meeting all other procurement standards should be tested for effectiveness and discomfort level and a final selection made. A form similar to Figure 1 can be completed on each product to facilitate formulation comparisons and insure that all important factors are being considered.

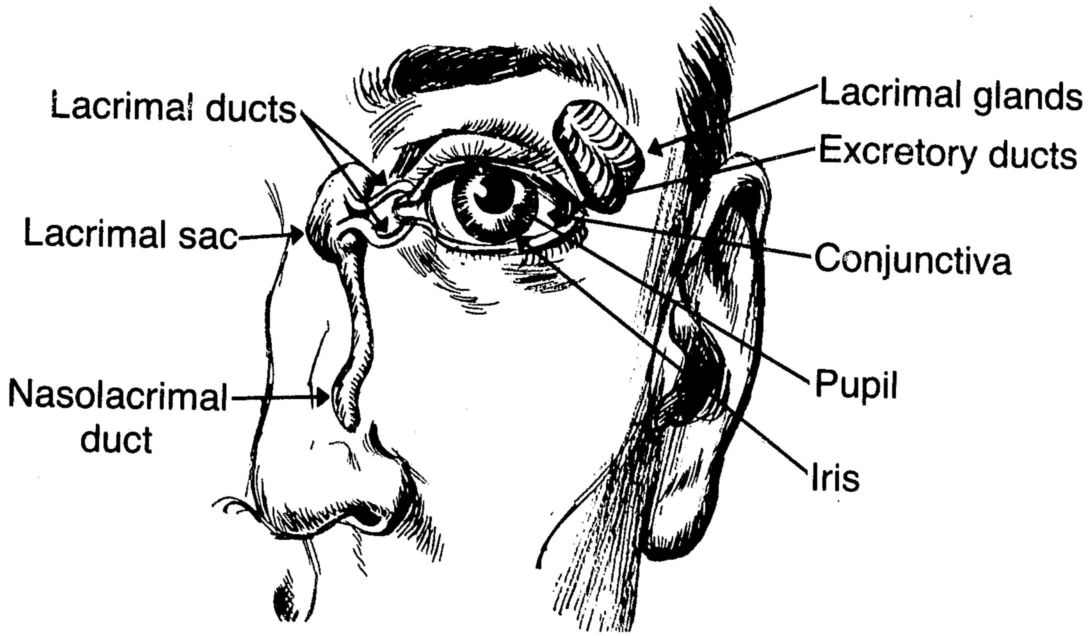
FIGURE 1 – COMPARISON OF AEROSOL IRRITANT PROJECTOR FORMULATIONS

	PRODUCT A	PRODUCT B	PRODUCT C
Injury Potential			
Eyes Positive or Negative	______	______	______
Skin Positive or Negative and Score	______ ______	______ ______	______ ______
Toxicity Rating of Principal Carrier/ Solvent	______	______	______
Effectiveness			
Lacrimation Score	______	______	______
Incapacitation Score	______	______	______
Comfort Level			
Severity Slight Mild Moderate Severe Extreme	______	______	______
Duration (Av. Number Minutes)	______	______	______
Other (See Chapter Five)			
Formula Available (yes or no)	______	______	______
Percent by Volume of Active Agent (not to exceed 2% if CN)	______	______	______
Non-Flammability (yes or no)	______	______	______
Contamination of Clothing or Equipment (yes or no)	______	______	______
Contamination of Area (indoors) None Mild Moderate Severe Extreme	______	______	______

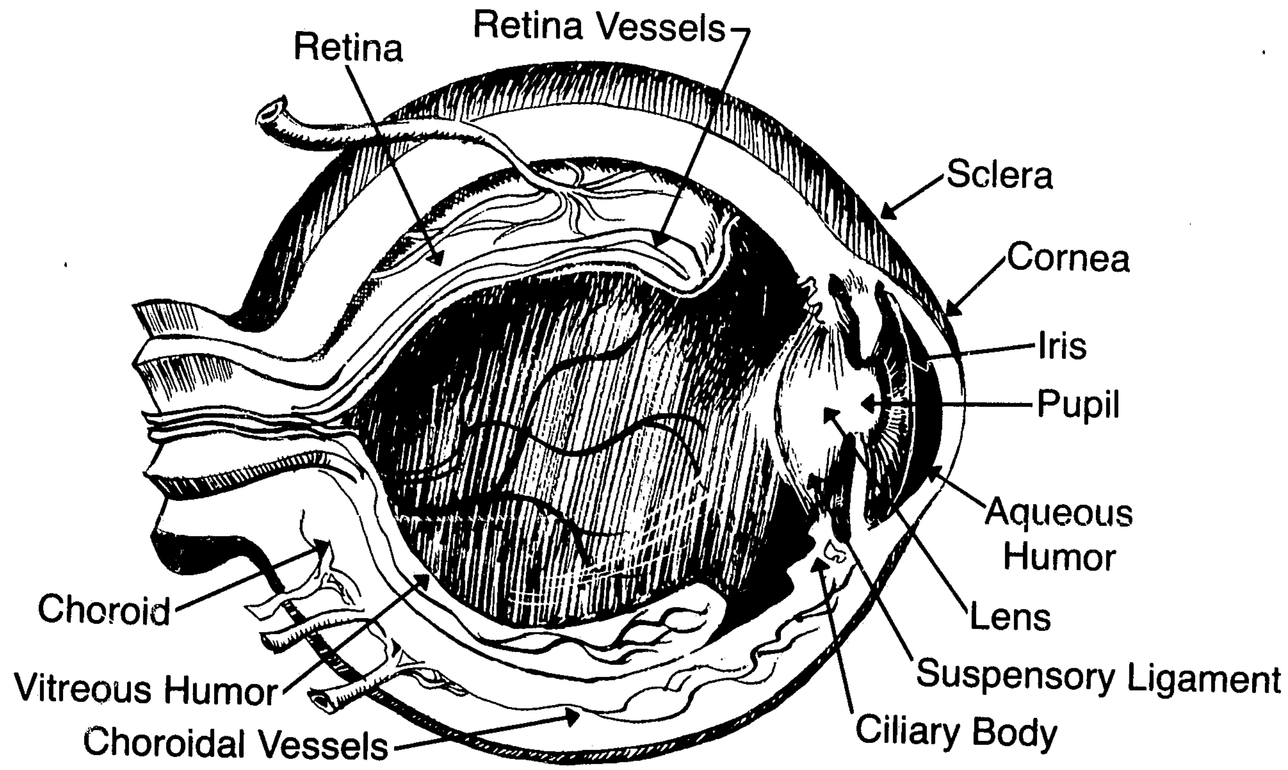
APPENDIX E GLOSSARY

Bulb	Any rounded mass, adj. *bulbar.*
Chemosis	Edema of conjunctiva of the eye.
Conjunctiva or Conjunctivae	A delicate membrane lining the eyelids and covering the eyeball.
Conjunctivitis	Inflammation of the conjunctiva.
Cornea	The transparent anterior part of the eye.
Diffuse	Not definitely limited or localized.
Edema	Abnormal accumulation of fluid in intercellular spaces of the body.
Erythema	Redness of the skin resulting from congestion of the capillaries.
Eschar	A necrotic mass ultimately separating from healthy tissue and being cast off.
Eversion	A turning outward.
FHSA	Federal Hazardous Substances Act.
Iris	The round pigmented membrane behind the cornea.
Lesion	A site of structural or functional change in body tissue produced by disease or injury.
Milliliter	Metric liquid measure. Approximately 1/30th of one fluid ounce.
Necrosis	Death of a cell as the result of disease or injury. adj. *Necrotic.*
Nictitating	Winking.
Ocular	Pertaining to the eye.
Opacity	The condition of being opaque.
Palpebra	Eyelid.
Palpebral	Pertaining to the eyelid.
Pupil	The opening in the center of the iris of the eye.
Toxicity	The quality of exerting deleterious effects on an organism or tissue.
Translucent	Slightly penetrable by light rays.
Ulcer	A local defect, or excavation of the surface of an organ, produced by sloughing of necrotic inflammatory tissue.
Ulceration	Formation of an ulcer.

THE EYE AND THE LACRIMAL APPARATUS



THE LACRIMAL APPARATUS



SCHEMATIC DRAWING OF THE EYE

To separate the pages of this manual for use in a three-ring notebook, cut where indicated by the broken line.

This cut can be made at a nominal cost by any printing shop.

CONVERSION TABLE OF COMPARATIVE WEIGHTS

1 grain	=	0.065	gram
1 gram	=	0.353	ounce
1 ounce	=	28.350	grams
1 pound	=	16	ounces

GRAMS	EQUIVALENT IN OUNCES	EQUIVALENT IN POUNDS
1	0.0353	.002206
2	0.0706	.004412
3	0.1059	.006618
4	0.1412	.008824
5	0.1765	.011030
6	0.2118	.013236
7	0.2471	.015442
8	0.2824	.017648
9	0.3177	.019854
10	0.3530	.022060
20	0.7060	.044120
30	1.0590	.066180
40	1.4120	.088240
50	1.7650	.110300
60	2.1180	.132360
70	2.4710	.154420
80	2.8240	.176480
90	3.1770	.198540
100	3.5300	.220600
200	7.0600	.441200
300	10.5900	.661800

END