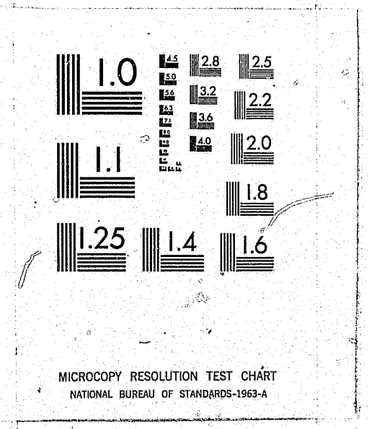

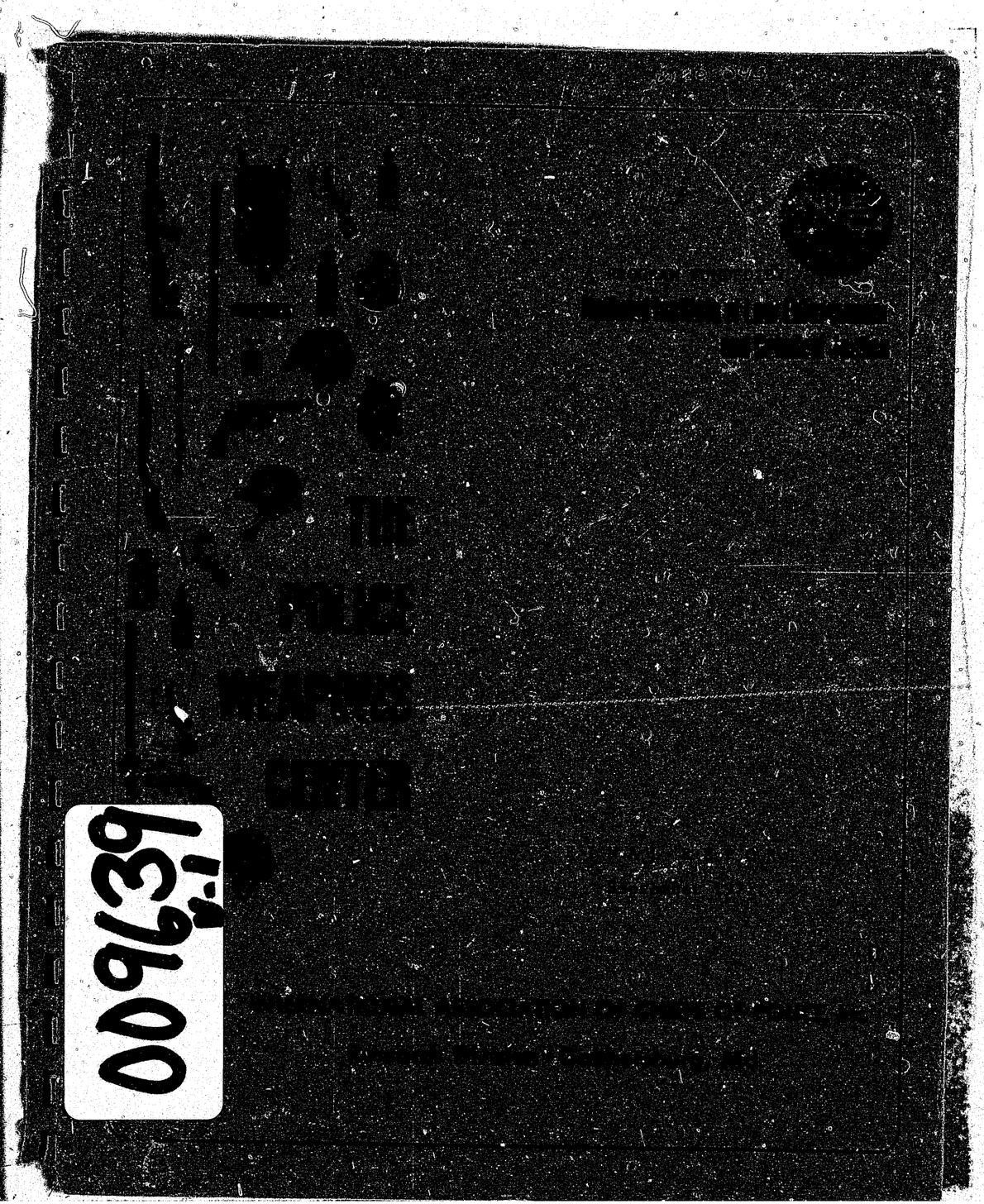

FINAL REPORT
POLICE WEAPONS CENTER

CONTENTS

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International Association of Chiefs of Police, Inc.
P.O. Box 19421
Washington, D. C. 20036
Phone (301) 948-0922
Cable Address IACPOLICE

THE POLICE WEAPONS CENTER

INTRODUCTION

During June, 1970, the National Institute of Law Enforcement and Criminal Justice (NILE) of the U. S. Department of Justice asked the IACP to establish a national Police Weapons Center (PWC) to collect, analyze, and disseminate information concerning requirements for, and evaluation of, police weapons systems and protective equipment.

The Police Weapons Center became operational immediately and actively began processing data in the following program areas:

I. Firearms
II. Chemical Weapons
III. Batons
IV. Explosives
V. Protective Equipment

Data collected and examined in each program area included product specifications, tactical applications, policy implications, performance characteristics, cost factors, and training requirements. As time and resources permitted, products were tested and evaluated, with results reported to law enforcement agencies.

The PWC program attempted to provide the information required by law enforcement agencies to formulate effective plans for the procurement and discriminate use of weapons systems, reducing the levels of violence associated with routine police operations and civil disorder.

However, the PWC not only endeavored to improve the use of currently available weapons systems, but also sought to define police requirements and stimulate research leading to the development of new or improved weapons systems.

Two series of PWC information publications were initiated under this contract and mailed to over 3,000 law enforcement agencies and interested individuals.

- Report Series

  General weapons and protective equipment information dealing with characteristics, tactical use, policy training, procedure, and evaluation.

- Police Casualty Series

  Statistical and summary report on police injuries and deaths from combat situations, including nature of injury, weapons involved, and other relevant data.

In addition to the development and dissemination of information publications, PWC responded to specific inquiries regarding any aspect of police weaponry and protective equipment. When the requested information was not available, limited research was conducted or other sources recommended. A high volume of inquiries for a specific kind of unavailable information occasionally resulted in the initiation of a substantial research effort.

The original process and product summary of PWC is illustrated in figure 1. The only significant modification of this system over the contract period was brought about by a subsequent decision on the part of NILE to separately fund the development of standards. Consequently, the process illustrated in figure 1 is substantially correct if the "Standards" box is deleted.

The International Association of Chiefs of Police continues to operate the Police Weapons Center at a reduced level of activity in the absence of LEAA/NILE funding.

National Institute of Law Enforcement and Criminal Justice

POLICE WEAPONS CENTER

International Association of Chiefs of Police

PROCESS AND PRODUCT SUMMARY

PROGRAM AREAS

I. FIREARMS
- Handguns
- Shotguns
- Rifles
- Automatic Weapons

II. CHEMICAL WEAPONS
- Aerosol Irritant Projectors
- Projectiles
- Grenades
- Bulk Dispensers

III. BATONS
- Nightsticks
- Blackjacks, Saps
- Riot Batons
- Special Purpose Devices

IV. EXPLOSIVES/DISPOSAL
- Bombs
- Grenades
- Incendiary Devices

V. PROTECTIVE EQUIPMENT
- Body Armor
- Vehicle Armor
- Masks
- Helmets
- Clothing

VI. UNCLASSIFIED

PROGRAM AREAS

INFORMATION COLLECTION
- Specifications
- Procedures
- Practices
- Policy
- Performance
- Training
- Costs

FIELD EVALUATION
Police Tactical Experience

TESTING
- Field Evaluation Testing (IACP)
- Laboratory Testing (Subcontract)

LIAISON
- Law Enforcement
- Military
- Commercial
- R&D Agencies

LITERATURE
Review of Available Sources

INFORMATION EVALUATION
- Responsiveness to Need
- Limitations
- Applications
- System Compatibility
- Cost/Effectiveness
- Versatility
- Management Considerations

INFORMATION DISSEMINATION
- Automatic
  - Cities Over 10,000 Population (1,900)
  - Counties Over 50,000 Population (575)
  - State Agencies (50)
  - Cooperating Agencies and Individuals
- Upon Request
  - All Other Cities
  - All Other Counties
  - Other Agencies and Individuals

Information Documents

Specific Inquiry Response

Planning and Program Development Assistance

Routine Reporting

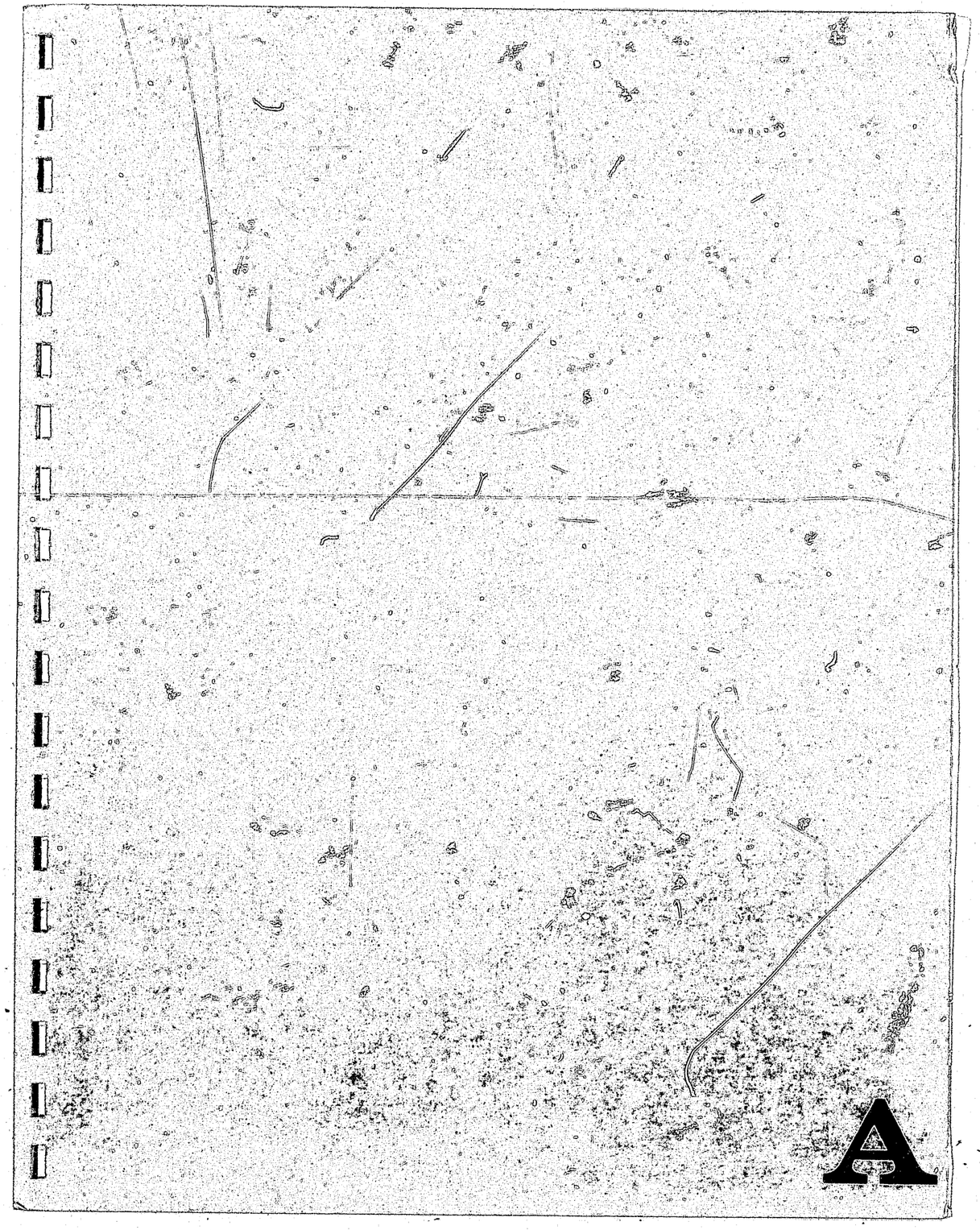
GUIDELINES
General Weapons Information Dealing With Characteristics, Tactical Use, Policy, Procedure and Evaluation

STANDARDS
Minimum Performance Standards, Specifications, and Performance Criteria

CLIENTELE
- U.S. Law Enforcement Community
- Research and Development Agencies
- Commercial Manufacturers and Distributors
- The National Institute of Law Enforcement and Criminal Justice

CLIENTELE

DIRECT CONSULTATION AND ASSISTANCE IN ESTABLISHING PRIORITIES AND PROGRAM EVALUATION



POLICE WEAPONS CENTER

SELECTED BASIC REFERENCE BIBLIOGRAPHY

Table of Contents

REPORT SERIES 1-70

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PROTECTIVE MASKS

LEONARD C. MILLER

REPORT SERIES 2-70

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PROTECTIVE MASKS

CONTENTS

PROTECTIVE MASKS

INTRODUCTION

The protective mask is designed to afford the wearer protection from the adverse effect of chemical agents in the air. Masks which protect against the particulates CN, CS and DM perform their function by preventing exposure of the respiratory track and the eyes, using a full face cover and a filtering device, which may be a canister or a filter pad, that removes the agent from the inhaled air.

Although Army protective masks must necessarily protect the soldier from lethal war gases as well as riot type agents, police masks require only the latter capability, and can therefore be simpler in design. *It should be noted that riot control masks will not protect against industrial poisons or the gaseous products of fire and they must not be used in atmospheres deficient in oxygen.*

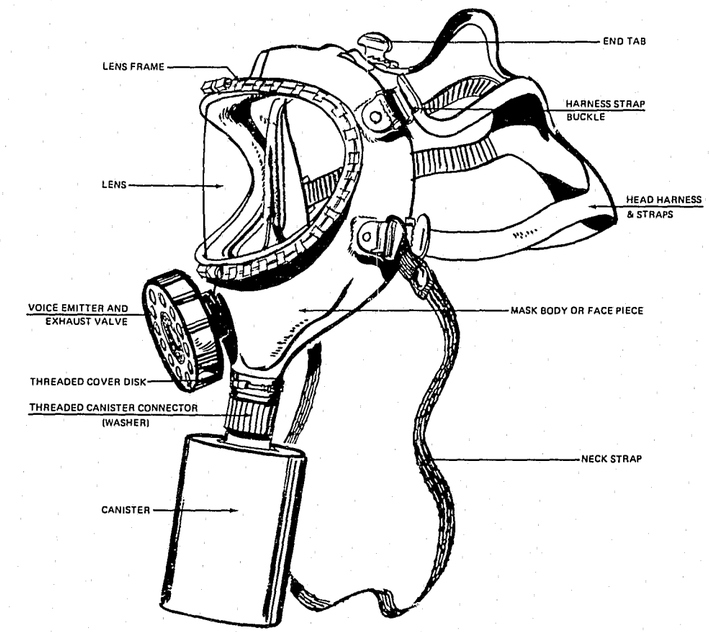


FIGURE 1 – RIOT CONTROL CHEMICAL AGENT PROTECTIVE MASK

The riot control mask canister (Figure 2) is a metal container with an intake opening at the bottom and a fitted outlet hole on top. The intake opening is equipped with a rubber valve (the inlet valve) which permits air to enter the canister but prevents breathing outward through the canister. Various types of filtering material are located within the canister to remove particles of agent from the air. Army field protective masks also have activated charcoal granules which function to remove the non-particulate (and usually more lethal) agents. After passage through the filter the air is breathable. Filter pads function in the same fashion but are enclosed in the face piece of the mask, making a separate canister unnecessary.

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 valve and channel. Contaminated air is drawn through the canister, filtered, and then flows up through the inlet channel of the face piece. In some masks 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. During inhalation the exhaust valve is forced shut. This air flow action is illustrated in Figure 3.

As the wearer exhales, pressure builds up within the mask. This pressure escapes through the least resistive outlet, and since the inlet valve is forced shut, the exhaled air is forced out through an exhaust valve located in 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. The operation of the inlet and outlet valve systems is illustrated in Figures 4 and 5.

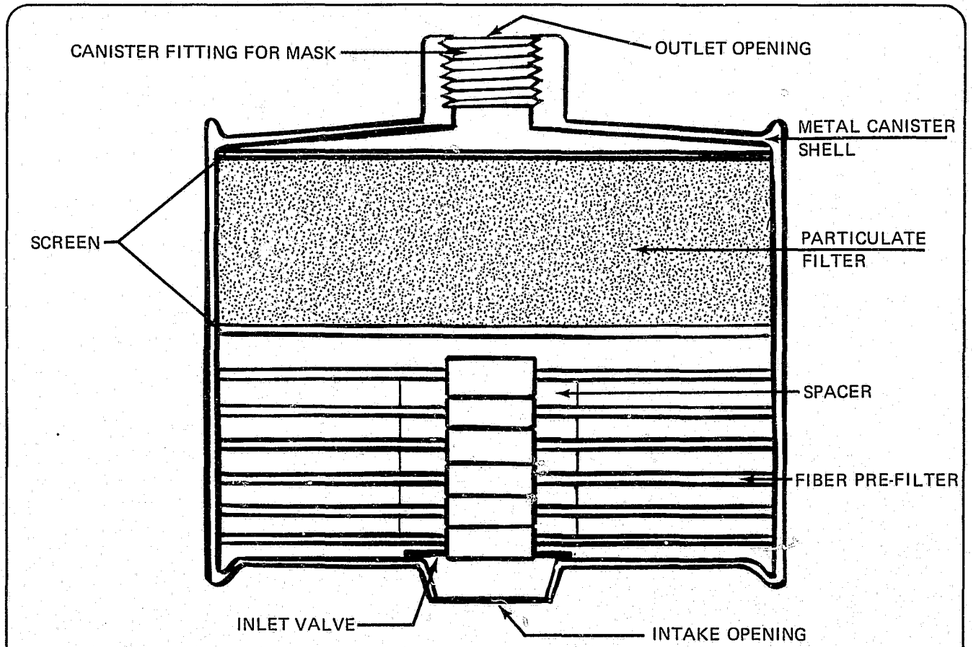


FIGURE 2 – RIOT CONTROL AGENT PROTECTIVE CANISTER

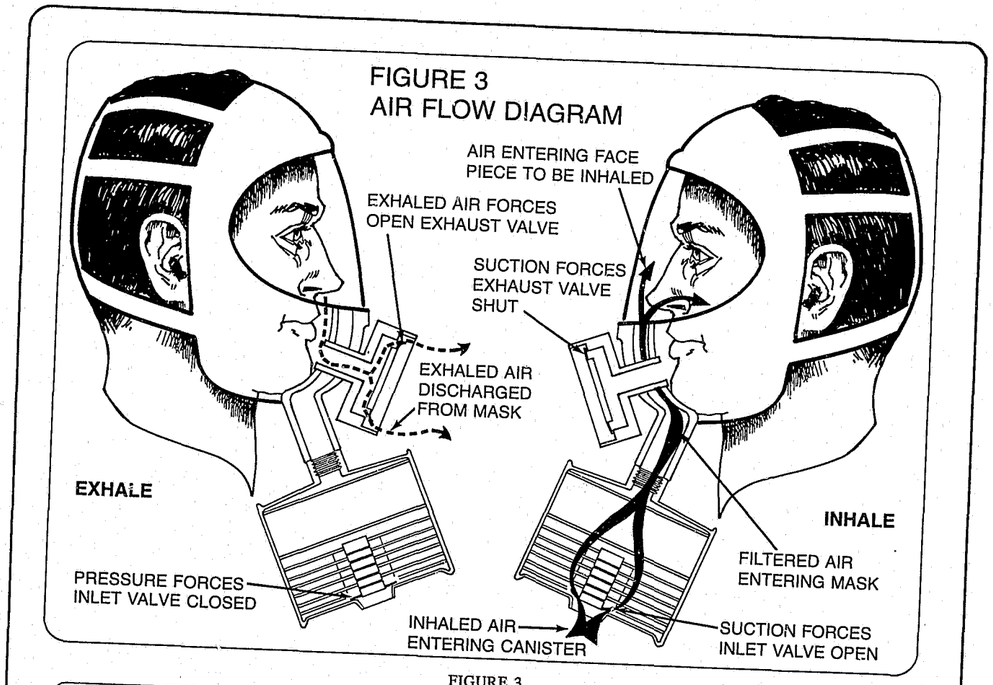


FIGURE 3

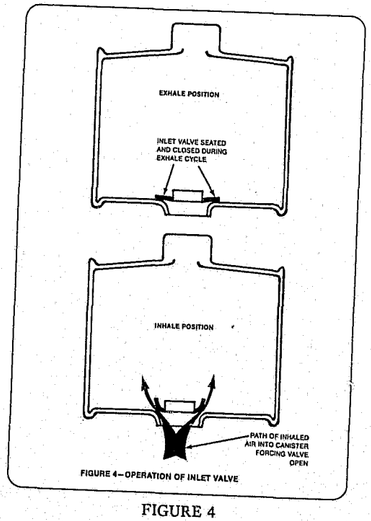


FIGURE 4

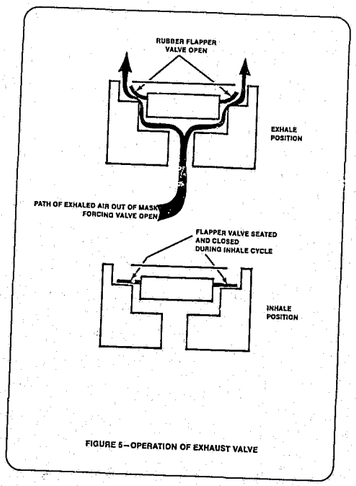


FIGURE 5

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.

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 employed. Should militant groups in fact use irritant chemicals against the police, the need for protective masks could well take on a grim new urgency.

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 fact that the Army will shortly surplus a large number of riot control masks originally designed for use in Southeast Asia. This is the XM28E4 mask which is described fully in a later section of this paper. The method by which the XM28E4 masks may be obtained is found in Police Weapons Center publication "Procedures for the Sale of Military Weapons and Protective Equipment to Public Safety Agencies" (Reprint Series 1-70.)

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:

1. 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.

2. 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.

3. 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 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 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 chemical 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 strap(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.
5. If the mask has been put on in a gas atmosphere it is necessary to get rid of any gas trapped between the mask and the face. Place palm of hand over exhaust valve and breathe out forcibly. Trapped air will be forced out around the face piece and can be heard escaping.

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 interfers 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.

EVALUATION OF AVAILABLE RIOT AGENT MASKS

The commercially available riot control agent protective masks included in this report are marketed by five companies:

Penguin Industries, Incorporated
P.O. Box 97
Parkesburg, Pennsylvania 19365

Lake Erie Chemical Division of Smith & Wesson, Incorporated
Rock Creek, Ohio 44084

Welsh Manufacturing Company
9 Magnolia Street
Providence, Rhode Island 02909

Mine Safety Appliances Company
201 N. Braddock Avenue
Pittsburgh, Pennsylvania 15208

Federal Laboratories, Incorporated
Saltsburg, Pennsylvania 15681

Also considered in this section are the XM28E4 Riot Control mask and the M17A1 masks manufactured for the U.S. Government. Samples of the most popular police riot control models of these manufacturers were evaluated and the results are summarized in Tables I and II below.

TABLE I
Characteristics of Riot Control Agent Masks

Serial No.	Source	Model	Size in Carrier	Weight With Carrier	Type	Catalog Price November 1970	Choice of Sizes
1	Penguin	WHGW	14-1/2 x 9 x 5	3 lbs	Chin Canister	36.95	No
2	Federal	6003	15 x 7 x 4	1.4 lbs	Chin Canister	35.00	No
3	Lake Erie	66	10-1/2 x 7 x 5-1/2	2 lbs	Chin Canister	32.00	No
4	Lake Erie	66B	10-1/2 x 7 x 5-1/2	2 lbs	Chin Canister	38.00	No
5	Lake Erie	67	15 x 10-1/2 x 6	2 lbs 3 oz	Chin Canister	38.00	No
6	MSA	88184	15 x 10-1/2 x 6	2 lbs 4 oz	Chin Canister	47.55	No
7	Welsh	7633W	8 x 8-3/4 x 5	2 lbs	2 Side Canisters	39.95	No
8	U.S. Army	XM28E4	8 x 5 x 2-1/2	1.5 lbs	Cheek Pads	1.88*	Yes
9	U.S. Army	M17A1	10-1/2 x 9-5/8 x 4-3/4	3 lbs	Cheek Pads	22.92	Yes

*Surplus Cost

In the scientific testing of these masks two critical points were examined: the penetration of the filter by agent, measured by the DOP test, and the breathing resistance of the filter.

DOP (Dioctyl Phthalate) is a liquid which produces a non-toxic smoke whose concentration can be measured electrically. It is routinely used by the Army and other gas mask manufacturers to measure the effectiveness of filters in removing toxic materials from the air. The measurements shown in Table II are in percentage of DOP which penetrates. The smaller the number the more effective the filter. The usual number considered acceptable by the Army is 0.25 percent. Thus, by government standards, all the masks tested are extremely effective in removing particulates (CS, CN, and DM) from the air.

Breathing resistance is the amount of effort that has to be exerted by the wearer to draw air in through a filter. This is a measure, in millimeters of water as indicated on a sensitive manometer, of the effort required to maintain a constant stream of air flowing through the canister. Here, again, the lower the figure the more efficient is the mask. The commercial filters tested all required less effort to breathe than did the Army masks.

The ability of a man to aim and fire shoulder weapons such as the rifle, submachine gun, or shotgun while masked was evaluated by members of the Weapons Center staff. It was found that all the commercially available masks made aimed fire extremely difficult or impossible, since the chin canister interfered with the ability to bring the sights into line with the aiming eye.

Also examined was the ability to transmit the voice while masked. It was found that unless the mask is provided with a voicemitter, it is not possible to speak intelligibly, and even with a voicemitter it would be difficult to issue commands in a loud tone.

TABLE II
Results of Evaluation of Selected Riot Control Mask Characteristics

Serial No.	Source	Model	Ability to fire shoulder weapon while masked	Voice X-Mission	%DOP Penetration	Breathing Resistance*
1	Penguin	WHGW	Poor	Fair	.003	46
2	Federal	6003	Medium	Poor	.0007	43
3	Lake Erie	66	Medium	Poor	.0008	22
4	Lake Erie	66B	Medium	Good	.0014	20
5	Lake Erie	67	Poor	Good	.0005	47
6	MSA	88184	Poor	Good	.0005	38
7	Welsh	7683W	Poor	Poor	.015	27
8	U.S. Army	XM28E4	Good	Poor	.003	65
9	U.S. Army	X17A1	Good	Good	.003	55

*in mm of water

PENGUIN, MODEL WHGW

Penguin Associates of Parkersburg, Pa. markets this mask which is actually manufactured by Wilson Products Division of the Electric Storage Battery Co., Reading, Pa. Packed in a carrying case 14 1/2" x 9" x 5" and weighing 3 pounds, this is a chin-canister type mask and costs $36.95. No choice of face size (S-M-L) is offered.

As with all chin-canister type masks, it is very difficult to fire a shoulder weapon when wearing the Penguin mask since the canister interferes with bringing the sights in line with the aiming eye. Also, running while wearing a chin-canister type mask can be difficult since the rapid motion of the canister may break the face seal and permit entry of gas around the face piece. Voice transmission is fair with the Penguin mask. The Penguin filter showed a DOP penetration of .003 percent and a breathing resistance of 46 mm. of water. Both these figures are very satisfactory.

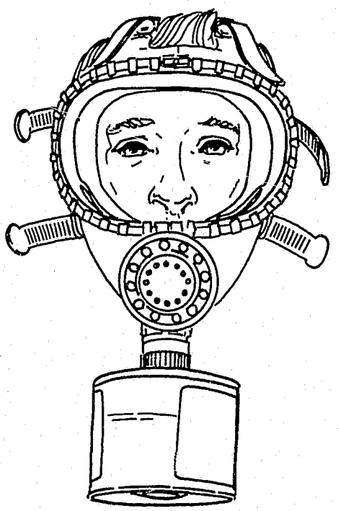


FIGURE 6

FEDERAL, MODEL 6003

Federal Laboratories, Saltsburg, Pa., markets this mask which is manufactured by Acme Protection Equipment Corporation of South Avon, Michigan. The mask is packed in a carrier which measures 15" x 7" x 4" and weighs 1.4 lbs. The Model 6003 markets at $35.30 and no choice of face sizes is available. It has a chin type canister.

Firing shoulder weapons with the Federal mask is very difficult but somewhat easier than the Penguin, and voice transmission is poor, since this model has no voicemitter. The DOP penetration (.0007 percent) and the breathing resistance (46 mm. of water) are both very good.

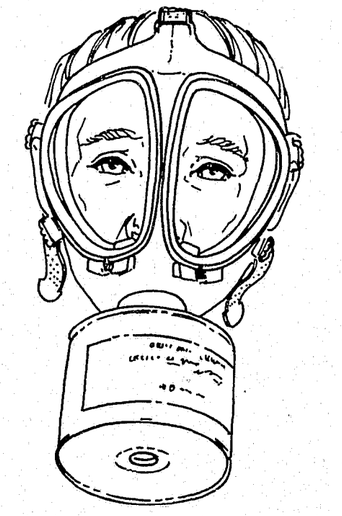


FIGURE 7

LAKE ERIE, MODEL 66

This mask, which is sold by the Lake Erie Chemical Co., Rock Creek, Ohio, is made by the Mine Safety Appliance Co., Pittsburgh, Pa., and is packed in a carrying case measuring 10 1/2" x 7" x 5". It weighs 2.0 lbs. and has a chin-type canister. It costs $32.00 and no choice of face sizes is available. Firing shoulder weapons with the Model 66, although difficult, is possible. Voice transmission is poor. The DOP penetration of .0008 percent and the breathing resistance of 22 mm. of water are both extremely good.

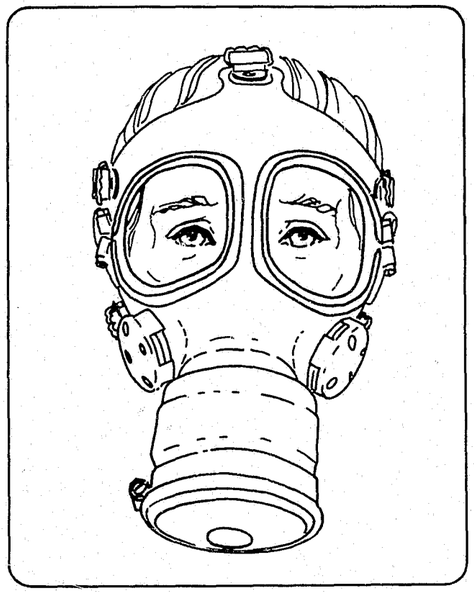


FIGURE 8

LAKE ERIE, MODEL 66B

This mask is identical to the Model 66, but has a voicemitter, which permits good voice transmission and adds six dollars to the purchase price. In all other respects the data presented above apply equally to the Model 66B.

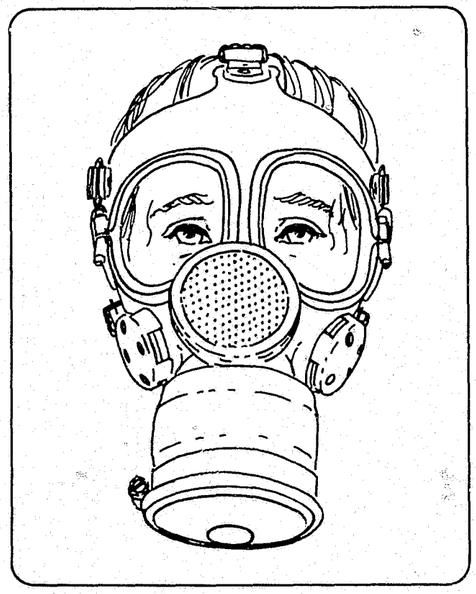


FIGURE 9

LAKE ERIE, MODEL 67

This model is equipped with the "Clearvue" lens which is stated to give wide angle of vision. The mask is packed in a carrier 15" x 10 1/2" x 6" and weighs 2 lbs. 3 oz. There is a chin type canister. The cost of this mask is $38 and no choice of sizes is provided. It was found virtually impossible to shoulder fire the rifle, shotgun, or submachine gun while wearing this mask. Voice transmission is good. On DOP penetration testing the Model 67 scored .0005 percent and the breathing resistance was 47 mm. of water. Both these figures are very good.

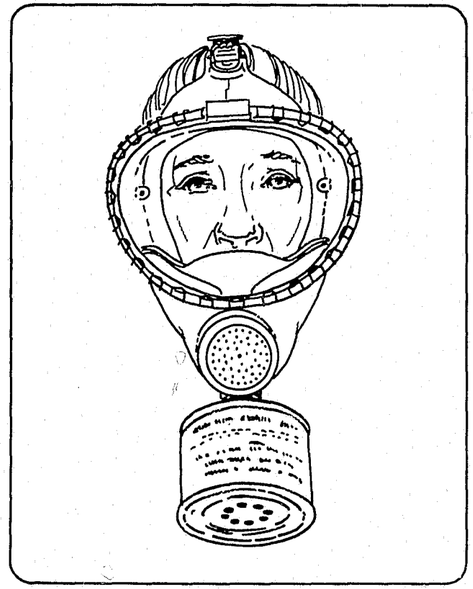


FIGURE 10

MSA, MODEL 88184

Mine Safety Appliances Co. of Pittsburgh, Pa., manufactures this mask which is identical to the Lake Erie model 67 described above, but has a different size and shape canister. In most respects the data given above apply to this item but the weight is 2 lbs. 4 oz. and the cost is $47.55. The breathing resistance is 36 mm. of water, slightly less than the Lake Erie Model 67.

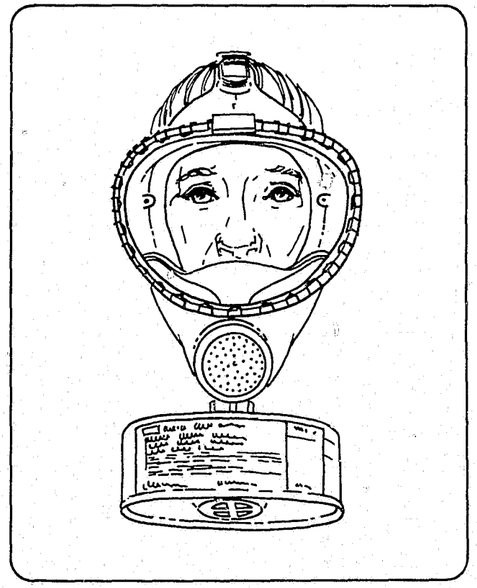


FIGURE 11

WELSH, MODEL 7683W

The Welsh Manufacturing Co. of Providence, Rhode Island, manufactures this model which is designed to give protection against riot control agents. It has twin canisters mounted on either side of the chin. It is packed in a carrying case measuring 8" x 8 3/4" x 5" and weighs 2 lbs. This mask sells for $39.95 and offers no choice of face sizes. Obviously the position of the twin canisters makes it impossible to aim and fire a shoulder weapon. The voice transmission is poor since no voicemitter is provided. The DOP penetration value of .015 percent, although considerably higher than other masks tested, is still within the safe range. The breathing resistance of 27 mm. of water is very good.

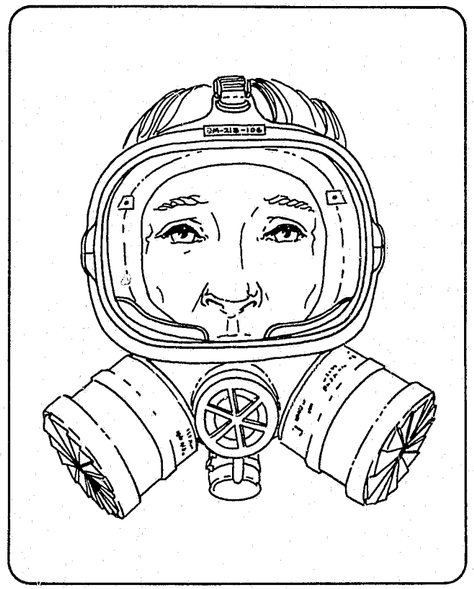


FIGURE 12

U.S. ARMY, MODEL XM28E4

U.S. Army, Model XM28E4 was designed for use in South-East Asia and protects only against riot control agents. Approximately 50,000 of these masks have been surplussed and will be sold under PL 90-500 to police departments. The XM28E4 is packed in a carrier 8" x 5" x 2 1/2" and weighs 1.5 lbs. This mask has no canisters; the filter elements are contained within the cheeks of the face piece. The mask is available in three sizes — small, medium and large. Since there is no canister, it is possible to fire a shoulder weapon. Voice transmission is poor, since no voicemitter is provided.

It should be noted that having been designed for use in Southeast Asia, the eyepieces have a tendency to fog up below 35 degrees F. The DOP penetration is .003 percent and the breathing resistance is 65 mm. of water. This is somewhat higher than that found for the commercial masks tested but is still within satisfactory limits. The acquisition cost of this mask was $18.77 and they will reportedly be sold to police at 1/10th the acquisition cost or $1.88 each.

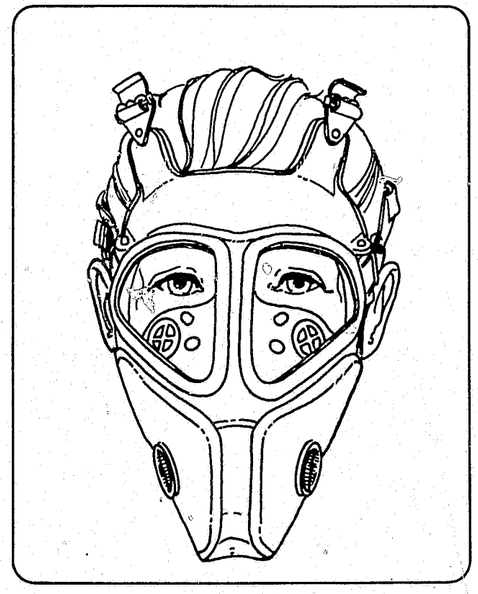


FIGURE 13

U.S. ARMY, MODELS M17 AND M17A1

The standard U.S. Gas Mask is the M17A1, but many of the earlier M17's are still in stock and may become available for sale or loan to police. Both these masks are fully protective against not only riot-control agents, but also the full range of lethal war gases. The M17 differs from M17A1 in that the latter is provided with a drinking tube which permits a masked man to have access to his canteen while still protected. The M17A1 also provides a means by which mouth to mouth resuscitation can be given. In all other respects the two masks are identical.

Like the XM28E4, the M17 mask has no canister. Filter pads located in the cheeks provide the necessary filtration of air. The M17 is carried in a canvas carrier 10 1/4" x 9 5/8" x 4" and weighs 3.0 lbs. The mask is available in three sizes, small, medium and large, and is excellent for use when firing shoulder weapons. The voice transmission is excellent. The DOP penetration is .003 percent and the breathing resistance is 55 mm. of water. These figures are considered very satisfactory.

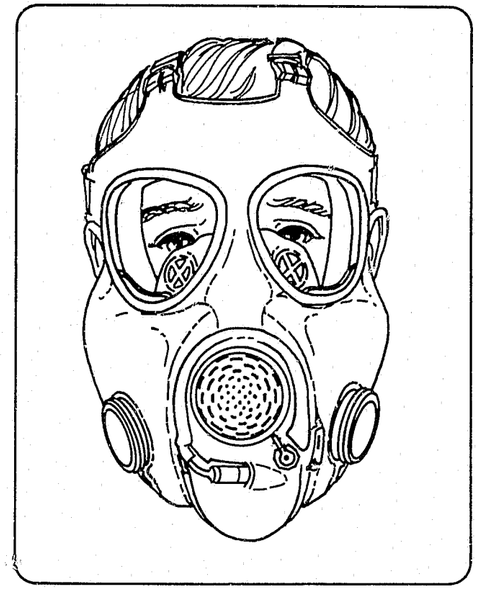


FIGURE 14

CONCLUSIONS

1. Very few changes have been effected by commercial gas mask manufacturers since the advent of the chin-canister and the consequent elimination of the long air hose. Although this change was an advantage in that it reduced the bulk of the mask, it did introduce the disadvantage that the chin canister interferes with aimed shoulder weapon fire. It also makes it difficult to run in a gas atmoshpere without endangering the wearer because of the bobbing of the canister and consequent danger of breaking the face-seal. The Army attempted to rectify the first of these disadvantages by placing the canister on the left cheek, as in the M-9 (the World War II mask), but this did not solve the problem of canister movement. The problem was eventually resolved by the invention of the filter pad concept and the development of the M17 mask, the Army's current field protective mask. The same principle was used in the XM28E4 mask.

It would appear that commercial producers could expend more effort in R&D to adapt the filter pad concept to police masks and to reduce the cost and bulk of their products. The ultimate goal might be a low cost mask which could be worn once and then discarded.

2. All the masks tested were rated as satisfactory for protection, regardless of their cost. However, more important than the cost is the condition of the mask when it must be used. Only if proper standards of storage and maintenance are followed rigorously, can the mask be expected to give perfect service when it is called upon.

3. It would therefore appear that maintenance and training are more important variables than mask model in assuring successful use of riot control agent protective masks.

POLICE WEAPONS CENTER PUBLICATIONS

The following publications are available upon request at no cost unless otherwise indicated.

REPORT SERIES

1-70 *Selected Basic Reference Bibliography*
2-70 *Protective Masks*

REPRINT SERIES

1-70 *Procedures for the Sale of Military Weapons and Protective Equipment to Public Safety Agencies*

CHEMICAL AGENTS SERIES

Police Chemical Munitions Handbook
Police Chemical Agents Manual ($1.50)
CS Characteristics (Brochure)
CS Decontamination (Brochure)

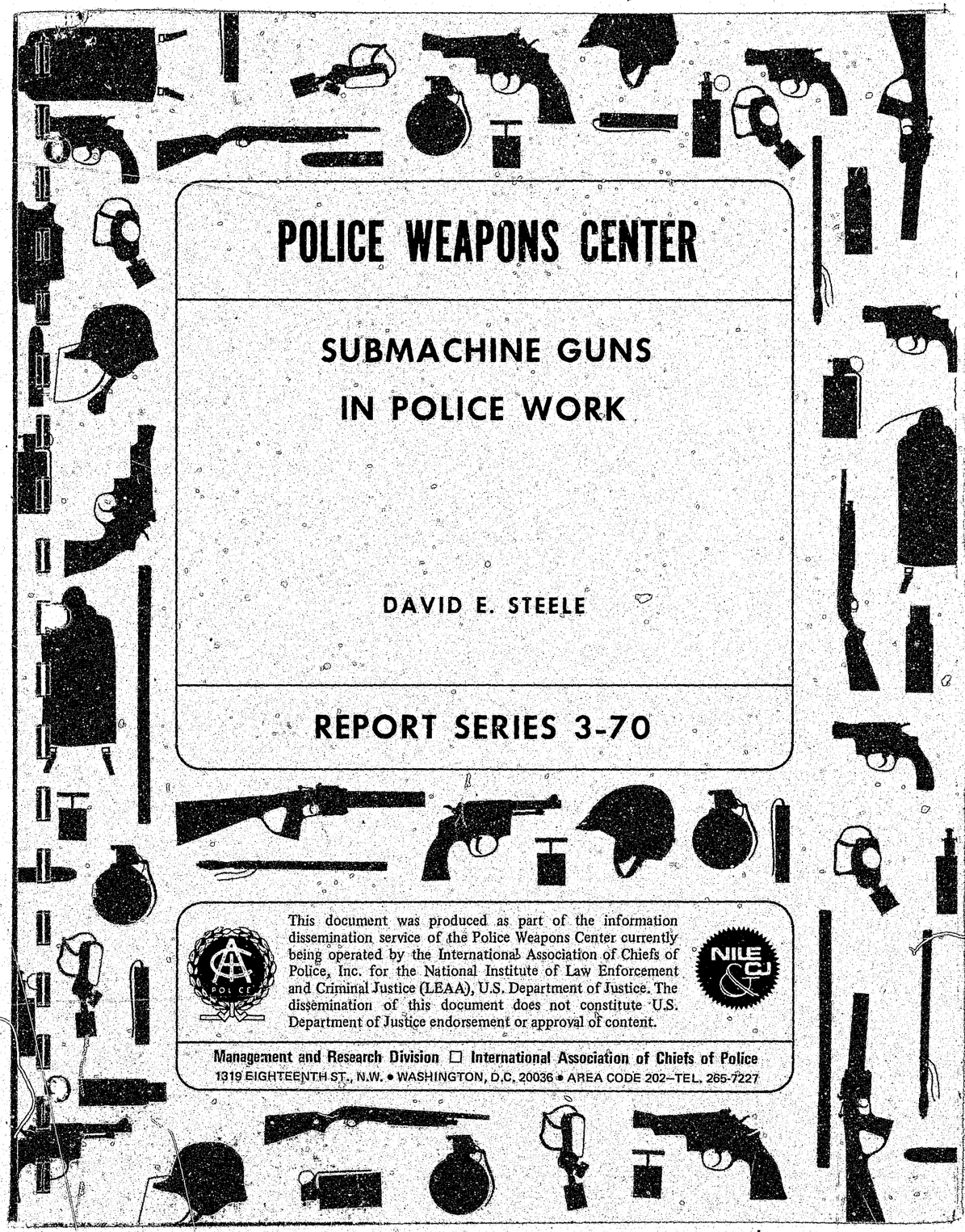
CHEMICAL AGENTS REPRINT SERIES

Toxicology of CN, CS and DM, Directorate of Medical Research, U.S. Army
Nonlethal Chemical Agents, Joseph F. Coates
Considerations in the Use of Irritants in Law Enforcement, Richard E. Reinnagel

PWC REPORT SERIES PUBLICATIONS IN PREPARATION

PWC staff and consultants are currently engaged in research in the following areas, and this work will be documented in future Report Series publications.

- *Police Armor*
- *Bomb Transport Vehicles*
- *Police Submachine Guns*
- *Batons*
- *Aerosol Irritant Projectors*
- *Protective Helmets*
- *Barricade Projectiles*
- *Urban Assault Tactics*



POLICE WEAPONS CENTER

SUBMACHINE GUNS IN POLICE WORK

DAVID E. STEELE

REPORT SERIES 3-70

Management and Research Division ☐ International Association of Chiefs of Police
1319 EIGHTEENTH ST., N.W. • WASHINGTON, D.C. 20036 • AREA CODE 202—TEL. 265-7227

SUBMACHINE GUNS

CONTENTS

SUBMACHINE GUNS IN POLICE WORK

INTRODUCTION

A submachine gun is generally defined as a hand held weapon utilizing a fixed or retractable shoulder stock, capable of burst or automatic fire with pistol ammunition.

The first weapon to fire pistol ammunition automatically was the Villar Perosa developed by Italy during World War I. This was the first true submachine gun though it bore little resemblance to its modern counterpart. With two barrels, two handgrips, and two trigger buttons, the Villar Perosa weapon resembled the later Browning .50 caliber heavy machine gun. The Villar Perosa failed as a light machine gun because its ammunition did not have the range or penetration of rifle cartridges. Later it was modified to rifle configuration with a shoulder stock and single barrel so that it could be carried and fired by hand, eliminating the need for vehicle or tripod mounting.

The modern phase of submachine gun history began with the weapon's popularization following the introduction of the Thompson submachine gun in 1921. The Thompson was the first mass-produced submachine gun and it sold in the millions. The Capone era gang wars in Chicago gave it a lasting, but unsavory image in police circles. However, in order to keep parity with criminal arsenals, Thompsons gradually became part of law enforcement armories in many cities.

The first major use of submachine guns in warfare occurred during the Spanish Civil War, 1935-1938. As mass production techniques began to improve, it was found that submachine guns made from metal stampings would perform as well at normal operating distances as the more expensively machined weapons such as the Thompson.

During World War II, Germany developed the MP38 and later the MP40 "burp guns." The United States introduced the M3 "grease gun," England made the "Sten gun," and the Soviet Union developed the PPSh41 "Shpagin" still used by Soviet border police. All these could be manufactured cheaply, and the submachine gun became the primary weapon of Soviet infantry in World War II and later for the Chinese forces in Korea.

The next step in the evolution of the submachine gun was its reduction in size. Folding stocks, often of skeletonized metal construction, became standard. The Czech ZK476 introduced the concept of telescoping part of the bolt over the rear of the barrel to reduce overall length. Soon after World War II, the idea of grip-feed came into prominence because a weapon that feeds through its pistol grip is not only shorter but is easier to load at night by the "hand-finds-hand" method. In another new development, plastic superseded wood in solid stock and foregrip construction. All these improvements were included in the Israeli-made Uzi submachine gun, which is now the most widely marketed machine pistol in the free world.

The trend in submachine gun design now seems to be toward a weapon which is lightweight and handles easily. The first submachine gun, the bulky Villar Perosa, fired 3,000 rounds per minute, the highest cyclic rate of any submachine gun developed to date. With the advent of a rifle-shaped submachine gun, the weight, as well as the cyclic rate, was reduced. Currently a rate of about 600 rounds per minute is favored in Europe, while the Soviets prefer a rate approaching 1,000 rounds per minute. The critical issue in design is one of weight versus controllability in full automatic fire.

As submachine guns approach pistol size, it is necessary to find ways of increasing accuracy and lessening muzzle climb while maintaining a cyclic rate high enough for suppression fire, as used in military attacks. The addition of muzzle breaks or compensators, recoil buffers, front handgrips, and straight-line stocks are all attempts to increase accuracy through greater controllability.

POLICE APPLICATIONS

The modern submachine gun is an extremely lethal weapon of war. It is designed primarily for combat situations where a high volume of fire can be employed indiscriminately to kill or suppress enemy forces. Because of the need for controlled and discriminate use of firepower in the typical law enforcement environment, the submachine gun has seldom been a weapon of choice for police agencies in the United States.

To supplement the handgun, most municipal and county law enforcement agencies have adopted the riot shotgun. The shotgun has lower penetration, higher first-round stopping power, and higher first-round hit probability for the nonexpert. An added advantage is the lower cost of shotgun training. It is generally agreed that shotgun qualification can be achieved in less time than submachine gun qualification and personnel entering police service are far more likely to be familiar with the shotgun than the submachine gun.

Considering the lack of formal acceptance of submachine guns by United States law enforcement agencies and the almost total absence of training doctrine and policy guidelines for their use, there is a surprising number of these weapons on hand in departments of all sizes in this country. A recent IACP Police Weapons Center survey indicated that there is also a wide assortment of these submachine guns, as summarized in figure 1.

Many police agencies are stocking submachine guns for which they have neglected to provide either training or policy guidance. In view of the nature of these weapons and the ramifications of their use, police administrators would be well advised to consider either disposing of submachine guns, or integrating them into the total police weapons system.

Tactical Requirement

Considering the nature of the submachine gun and the environment in which the agency operates, what tactical situations would lend themselves to the effective use of such weapons? Put another way, in what police combat situations would the characteristics of the submachine gun maximize the chances of successful police action with minimum risk of injury to innocent persons? Unlike the soldier, whose mission is destruction of the enemy, the police officer must always be prepared to waive efficiency or even self-defense in favor of public safety.

Can a tactical role for the submachine gun be identified in the average police department? For most police agencies, almost all possible tactical applications fall into one of three categories:

1. **Protection of Dignitaries.** While the compactness, firepower and mobility of some modern submachine guns have led to this weapon's use in the protection of important officials, the typical crowded environment engendered by the public appearance of certain politicians would severely limit the utility of the submachine gun. The use of an automatic weapon in a crowd by a well-trained security expert to protect the President of the United States might be justified, but the acceptance of such risk in more routine protective work would be more difficult to support.

FIGURE 1
SUMMARY OF SUBMACHINE GUN SECTION
1970 IACP WEAPONS SURVEY

	(26)* Over 1,000,000		(35) 999,999–250,000		(34) 249,999–100,000		(73) 99,999–50,000		(95) 49,999–25,000		(133) 24,999–10,000		TOTALS	
Types of Submachine Gun (SMG)	Number of Departments	Approximate number of weapons on hand	Dept.	Weapons	Dept.	Weapons	Dept.	Weapons	Dept.	Weapons	Dept.	Weapons	Dept.	Weapons
Danish Madsen SMG (9 mm)	1	2							1	6	1	1	3	9
Eagle Carbine (Converted to SMG) (.45 a.c.p.)									1	1			1	1
German Schmeisser MP 38/40 (9 mm)							3	4	2	3	4	5	9	12
Ingram Model 6 SMG (.45 a.c.p.)	1	2	1	2	1	1	2	2			3	3	8	10
Italian Beretta 38/42 (9 mm)							2	2			1	1	3	3
Reising (Harrington & Richardson) M50, M55 & M60 SMG (.45 a.c.p.)	5	47	10	57	9	34	16	40	21	42	21	39	82	259
Smith & Wesson M76 SMG (9 mm)	2	130					4	19	4	19	3	5	13	192
Spitfire Carbine (converted to SMG) (.45 a.c.p.)	1	2					1	2			2	2	4	6
Thompson SMG Models: 1921, 1928, 1928A1, (.45 a.c.p.)	13	183	20	114	23	60	40	80	44	75	35	45	175	557
U.K. Sten MK11 (9 mm)											1	1	1	1
U.S. M3 or M3A1 "Grease Gun" SMG (.45 a.c.p.)			1	1					1	2	1	1	3	4
Uzi SMG (Fabrique Nationale) (9 mm)	2	31											2	31
Totals	25	397	32	174	33	95	68	149	74	148	72	103	304	1,085

*Agencies reporting in each population category.

2. **Security.** The submachine gun is also employed in the security of certain critical governmental installations. Again, firepower, compactness and mobility are both useful and usable in carefully controlled situations involving national security. Short of full-scale urban warfare, however, the use of submachine guns in routine physical security work would probably generate more problems than solutions.

3. **Raids and Assaults.** The submachine gun is most compatible with its designed function in police operations involving raids or assaults on fortified or heavily defended positions. In instances where police encounter substantial armed resistance and the environment permits the use of automatic weapons without risk to innocent lives, the discriminate use of the submachine gun against barricaded criminals may be effective.[1]

The more closely police operations approximate military combat, the more useful the submachine gun. The three characteristics of firepower, compactness and mobility that make the submachine gun a useful military weapon can also reduce the risk of police casualties by terminating what might otherwise be a prolonged fire fight.

In the final analysis, the decision to train and equip law enforcement officers with submachine guns will have to be made on the basis of an assessment of local tactical requirements as weighed against the disadvantages of these weapons. In any event, at the present time in the United States, the submachine gun is regarded as a highly specialized weapon with a narrow range of applications in general police service. As with any special purpose weapon, there is always a strong possibility that the submachine gun will be overlooked in both the formulation of policy and the design of training.

Policy Formulation

Policy formulation involves deciding *what* will be done and procedure directs *how* it will be accomplished. In any law enforcement agency, firearms policy will either be formulated by executive leadership and clearly stated to operations personnel, or it will be formulated and executed on the street by each officer in response to his perception of each situation. Policy covering all firearms, especially potentially controversial and dangerous automatic weapons, must be established and disseminated.

For example, policy relating to submachine guns should, as a minimum, answer the following questions:

- **WHY will the agency employ the submachine gun as a component of the weapons system?**
- **WHO will use the submachine gun?** What personnel will be authorized to use a submachine gun: How will they be identified? How will their qualification be established and maintained?
- **WHEN and WHERE will submachine guns be employed?** Under what conditions will use of automatic weapons be authorized? Who will make the decision to employ these weapons in the field?

[1] If, however, greater penetration is desired, a rifle would be a better choice than a submachine gun. For example, 5.56 mm assault rifles such as the Colt AR15, the Armalite AR180, and the Stoner 63 all offer greater range, penetration and accuracy.

- **HOW will the submachine gun be used?** What tactics and general operational guidelines will be employed?

- **WHAT procedures will be employed for managing the submachine gun subsystem?** How will submachine guns be procured, secured, maintained, and transported? How will users be selected, trained, and maintained at an acceptable level of performance? How will controls be provided?

Once policy has been developed, it must be implemented by the dissemination of clear procedural guidelines. Figure 2 illustrates one format that might be adopted to insure that important points are covered. However, the format is less important than the content, which must be clear and concise.

Organization

Because of its highly limited police applications, the submachine gun, if used at all, will for the forseeable future remain a secondary weapon for carefully selected and trained officers assigned to special response units.

If personnel with prior civilian or military experience in the use of automatic weapons are selected for submachine gun training, the cost of such training can be reduced substantially. Even extensive experience with rifles or shotguns will increase the rate at which submachine gun training can be absorbed.

Regardless of background, however, the police officer to be selected for submachine gun training must be emotionally stable, mature, and naturally restrained in the use of force. Unfortunately, personnel attracted to special weapons units are not always the most psychologically suited to such assignment. The submachine gun has a great potential for destructive misuse that can only be balanced by human discretion.

FIGURE 2
PROCEDURE FOR USE OF SUBMACHINE GUNS

PROCEDURE NUMBER

Field Operations and Enforcement

TO: ALL MEMBERS

RE: SUBMACHINE GUNS

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 submachine guns (automatic weapons firing pistol ammunition) by departmental members.

B. POLICY

1. Only authorized members may use the submachine gun furnished by the department as an offensive or defensive weapon in accordance with this order.

2. The use of the submachine gun shall be considered an alternate action to the use of the police shotgun under appropriate circumstances and is not intended as a replacement for the shotgun or high-power rifle.

3. Submachine guns shall not be discharged in any situation where there exists any risk of injury to innocent persons. Personnel armed with submachine guns will withhold automatic fire rather than risk accidental injury or death.

C. GENERAL

1. Submachine guns are intended for use in those cases wherein the authorized member is attempting to subdue an armed attacker or an entrenched suspect resisting with firearms or under other circumstances, within the rule of law, which permits the lawful and necessary use of extreme force and which is best accomplished by the use of a medium-range shoulder weapon capable of automatic or single fire.

2. Submachine guns shall not be used indiscriminately or in anticipation against mere threat of armed attack or resistance.

3. The submachine gun shall be carried by means of a canvas web sling for uniform wear, or by means of a sling or special holster for concealment under plain clothes.

FIGURE 2
PROCEDURE FOR USE OF SUBMACHINE GUNS (Continued)

D. PROCEDURES FOR USE

1. Submachine guns furnished under this order are manufactured with a retractable metal stock which should be carried extended for uniform wear, and retracted for concealment under plain clothes.

   a. The gun shall be carried with stock extended in anticipation of use except when transporting the weapon or concealing it under plain clothes.

   b. An "open-bolt" firing gun shall be carried with the bolt closed and the selector lever pointing to the "semiautomatic" position.

   c. A "closed-bolt" firing gun shall be carried with a round in the chamber and the selector lever pointing to the "safe" position.

   d. Submachine guns shall be carried with the muzzle of the gun pointing either upward or downward, in a safe direction.

2. Use of submachine guns shall normally be limited to a range of 200 yards for semiautomatic fire and 50 yards for full automatic fire.

3. The submachine gun shall be fired from the shoulder unless the range to the target is less than ten yards *and* the imminence of armed attack precludes bringing the weapon to the shoulder.

4. Fleeing dangerous felons shall normally be fired upon with semiautomatic fire only.

5. Authorized members shall carry one loaded magazine in the gun and one spare loaded magazine.

6. Following are the normal uses of the submachine gun to be authorized by the commander:

   a. Stakeouts for known armed, dangerous felons.

   b. Raids on sandbagged or otherwise fortified criminal positions.

7. In normal operations, only one man on any raid or stakeout shall be authorized to carry or use the submachine gun.

   a. This will minimize the risk of indiscriminate crossfire.

   b. All others should carry shotguns, carbines, or rifles depending on tactical needs.

   c. Additional submachine gun authorizations will be made only by the operation commander.

8. If sniper fire can be determined to come from a particular window, the submachine gunner shall accurately place two or three-shot bursts into that window while other officers advance on the building.

   a. Countersniper fire shall *not* be returned with pistols or revolvers after heavier weapons have been brought to the scene.

   b. High-power rifle fire shall not be directed against a sniper except by expert marksmen.

   c. Shotgun-armed members may direct countersniper fire at the discretion of the operation commander.

9. Submachine guns shall not be fired from moving vehicles.

10. Submachine guns shall be fired at moving vehicles only under emergency conditions and when the public safety shall be endangered less by their use than by their nonuse.

E. PROCEDURE AFTER USE

1. The immediate superior of the authorized submachine gun user shall check the number of rounds expended from each issued magazine at the end of each operation or tour of duty.

   a. The submachine gun user is not authorized to carry extra ammunition for his submachine gun during his tour of duty.

   b. The command to resupply ammunition during an operation will be made by the operation commander.

   c. The submachine gunner may be issued more than two magazines for an operation only by the direction of the operation commander.

FIGURE 2
PROCEDURE FOR USE OF SUBMACHINE GUNS (Continued)

2. Department submachine guns shall be stripped and cleaned only by the department armorer. They shall be cleaned thoroughly after every use, and they shall be inspected for dirt and rust before and after each time they are issued by the officer in charge of the armory. In addition, submachine guns in the armory shall be inspected at least once every sixty days and the inspection noted in the records of the armorer.

F. REPORTING

1. Standard Form_____, After Action Report, shall be completed in detail each time the submachine gun is fired other than on the range.

2. Standard Form_____, Fatality (Other Than Motor Vehicles), shall be completed whenever someone is injured or killed with the submachine gun, and a detailed statement on circumstances surrounding the incident shall be dictated by the officer involved and copies sent to the Internal Affairs Division and the department's legal advisors.

G. DISTRIBUTION OF SUBMACHINE GUNS

Submachine guns, ammunition, and special purpose carrying devices may be obtained by authorized members through requisition procedures contained in chapter___of the *Administrative Procedures Manual.*

TRAINING

In training police personnel to fire the submachine gun, it must be emphasized that the degree of accuracy and safety required will greatly exceed that necessary in most military operations. As a result, certain military practices are not included in police training. For example, the hip-fire or assault position is not employed at distances exceeding 10 yards, and the technique of "walking" rounds onto a target is eliminated completely.

For distances beyond the 10-yard hip-fire limit, a shoulder pointing technique similar to the Army's "quick kill" rifle training can be used. In this technique the weapon is held at the shoulder, but the eyes look *over* the sights at the target. With practice, the shooter and gun become a single unit so that the officer can hit whatever he looks at. This technique, good up to about 50 yards, allows the shooter to readily "spot" his hit so that he can adjust his shots on target. For precise one or two-shot hits on targets out to 100 yards, the sights should be used and both eyes should remain open during firing to judge distances and to spot hits.

Basic Positions

The shooter should be thoroughly instructed in proper body positions. This is especially important in submachine gun firing. For police work, four of the basic military firing positions are recommended:[2]

Standing. This is normal firing position. To assume this position, stand facing the target, then make a half right face. Move the left foot forward one step, pointing the left toe toward the target. Lean forward; bend the left knee slightly, keeping the right leg straight, with about two-thirds of the body weight on the left foot. Grasp the magazine or foregrip with the left hand and the pistol grip with the right hand. Place the butt of the stock against the right shoulder, and twist the body at the waist to the left to bring the right shoulder forward. The left elbow should be under the weapon, and the right elbow should be shoulder high. Press the cheek against the stock. The recoil is slight for single shots but recoil in automatic fire tends to push the shoulder rearward. Therefore, the gun will move off the target if the firer is not well braced and in the proper position. This position is illustrated in figure 3.

Kneeling. The kneeling position which is shown in figure 4, affords a steadier aim than the standing position and is useful when the firer can crouch behind a rock, log, or other protection. The kneeling position is frequently used on level ground or ground that slopes upward. To assume this position, face the target, half face to the right, and kneel on the right knee. Sit on the right heel, with the right thigh forming an angle of 90 degrees to the line of aim. The entire surface of the lower right leg, from knee to toe, is in contact with the ground. The left foot should be placed about 18 inches to the front, with the toe pointing at the target. The left lower leg is vertical when viewed from the front. Move the weight of the body forward, and place the point of the left elbow a few inches forward of the knee. The right elbow is raised to the height of, or slightly below, the right shoulder.

[2] Department of the Army, *FM23-41: Submachine Guns Caliber .45, M3 and M3A1* (Washington, D.C.: Headquarters, Department of the Army, 1957) pp. 53-54.

FIGURE 3
STANDING POSITION

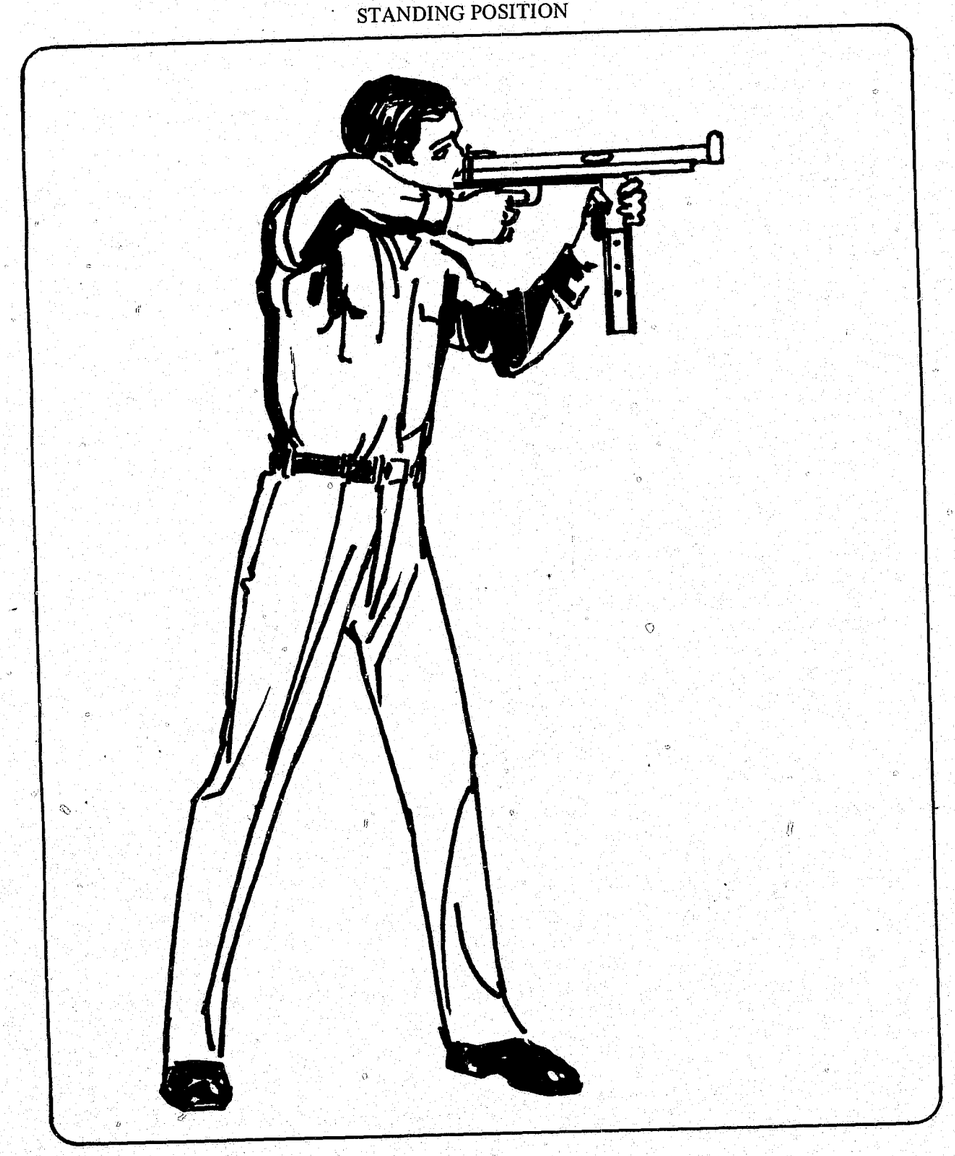
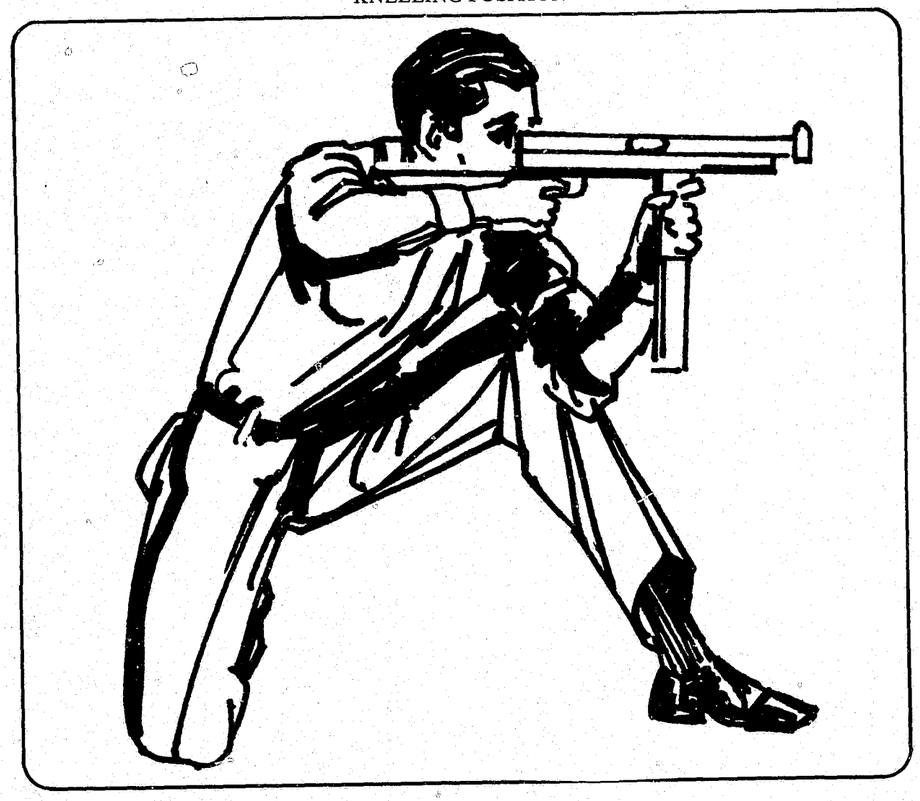


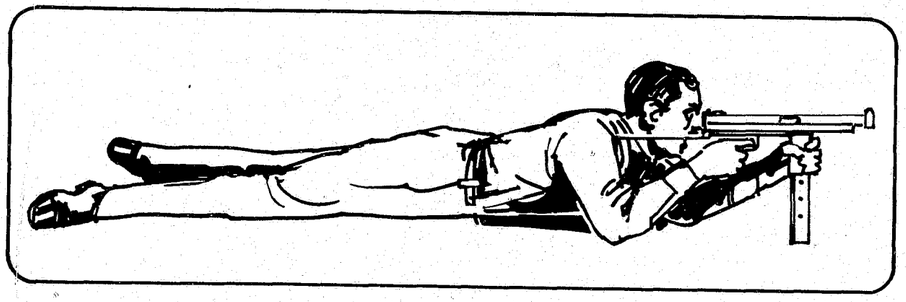
FIGURE 4
KNEELING POSITION



Prone. This position is the steadiest and should be used whenever time and terrain permit. Take a prone position, with the body inclined to the left of the line of aim at an angle of 20 degrees or less. Spread the legs a comfortable distance apart, with the toes pointed outward, and keep the spine straight. Place the left elbow under the gun, with the left hand grasping the magazine or foregrip. The right elbow is out from the body so that the shoulders are level. Place the butt of the stock in the pocket formed by the shoulder, and press the cheek against the stock, as illustrated in figure 5.

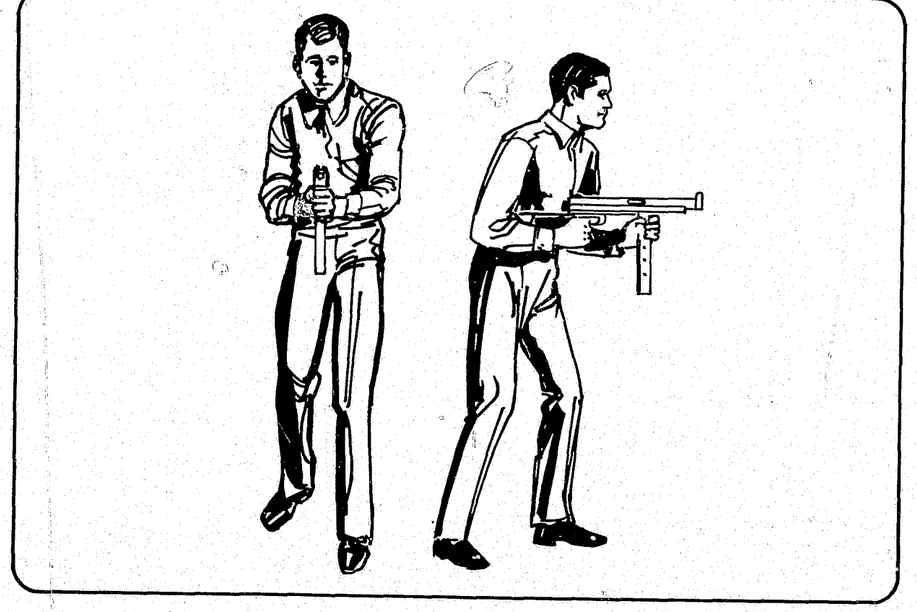
Hip-Fire (Assault). This position, usually called the hip position or underarm position, is used at ranges up to 10 yards. The sights are not used to aim the weapon; the firer simply points the weapon toward the target and commences firing. The shooter must have a great deal of practice before he can do accurate shooting. To assume this position, press the stock against the side of

FIGURE 5
PRONE POSITION



the hip with the right arm, or place the stock under the armpit and press it against the body. The body should be in a crouched position, as shown in figure 6, and the firer should walk with his weight forward so that he can quickly shift his body to fire at targets to his side.

FIGURE 6
HIP-FIRE POSITION



Curriculum

While the nature and scope of submachine gun training may vary somewhat in response to local conditions and the previous experience of the trainees, any program that falls short of the minimum standards suggested below should be carefully reviewed to insure that adequate instruction is being provided. For example, military doctrine, as expressed in FM 23-41, calls for 30 hours of training to qualify personnel armed with the M3 and M3A1 submachine guns. With greater accuracy and safety requirements, police training could hardly hope to accomplish substantially more in any shorter period of time. A comparison of the military and civilian training schedules is made in figure 7.

FIGURE 7
MILITARY AND POLICE TRAINING SCHEDULE COMPARISON

MAJOR TOPIC	Recommended Hours Military	Police
Mechanical Training	5	5
Preparatory Marksmanship	13	13
Agency Policy	0	1
Tactics	0	5
Range Firing*		
Instruction Firing	9	24
Qualification Firing	3	8
Total	30	56

*Required hours depend upon the capacity of range facilities

Mechanical Training (5 hours). This segment of the training can be conducted in a classroom if tables are available. Unlike similar military training, instruction will not be provided in detailed disassembly and assembly, since such work will be performed only by the agency armorer.

Hours	Subject Area
1	Introduction to submachine guns, identification and characteristics of common submachine guns
1	Characteristics, general data, nomenclature, field disassembly and assembly of weapon used by the police agency, including operation check, ammunition, and magazine loading.

1	Functioning.
1	Malfunctions, stoppages, and immediate action; care and cleaning.
1	Examination by demonstration of mechanical skills.
5	

Preparatory Marksmanship (13 hours). As with any firearms training, the preparatory marksmanship portion of submachine gun instruction is critical to the ultimate success of the trainee in actual firing exercises. While some time may be saved by reducing this segment of the training for experienced personnel, excessive cutting will almost certainly result in increased range time and/or trainee failure.

Hours	Subject Area
2	Orientation on marksmanship: sighting and aiming exercises.
2	Firing positions: standing, kneeling, prone, and hip-fire.
1	Trigger manipulation, safety precautions, loading and unloading.
6	Marksmanship exercises.
1	Special techniques for firing at moving targets or from vehicles at stationary or moving targets.
1	Examination
13	

Agency Policy (1 hour). Instruction in agency policy relating to the employment of the submachine gun in police operations.

Tactics (5 hours). Classroom instruction, demonstration, and practice in tactical employment of the submachine gun in those situations where its use is approved or required by agency policy.

Range Firing (32 hours). For instructional and qualification firing, a 100-yard range will be required. Damage produced to target frames and butts will generally preclude the use of existing standard pistol ranges, but those agencies large enough to consider submachine gun training should be capable of providing at least minimum adequate range facilities.

A recommended firing course, summarized in figure 8, consists of a three-stage sequence employing four basic positions and 58 rounds of automatic and semiautomatic fire.

At each stage of the dismounted course, the trainee will fire at three silhouette targets (figure 9), spaced four feet apart, to develop and demonstrate skill in engaging multiple targets in quick reaction time. Wherever possible, the bobbing or pivoting type illustrated in figure 10 and 11 should be employed to add realism and develop quick response. Targets should be engaged from left to right during training to promote safety and ease of scoring even though the order of target engagement will vary in combat situations.

Trainee action at each stage of the dismounted course is summarized below:

- **10 yards** — Trainee loads six rounds and takes the hip-fire position, with the weapon held firmly in line with the eyes. On command, two rounds are fired on each of the three targets. The trainee reloads eight rounds and on command fires an automatic burst of not more than three rounds at each silhouette.

FIGURE 8

SUBMACHINE GUN FIRING COURSE

Range	Targets	Position	Maximum Time	Rounds
10 yards	Army F or NRA B-29	Hip-Fire	10 sec. 10 sec.	6 semiautomatic 8 automatic
50 yards	Army E or NRA B-27	Shoulder	10 sec. 10 sec.	6 semiautomatic 8 automatic
100 yards	Army E or NRA B-27	Kneeling and Prone	150 sec. 150 sec.	15 semiautomatic 15 semiautomatic

FIGURE 9
SUBMACHINE GUN COURSE TARGETS

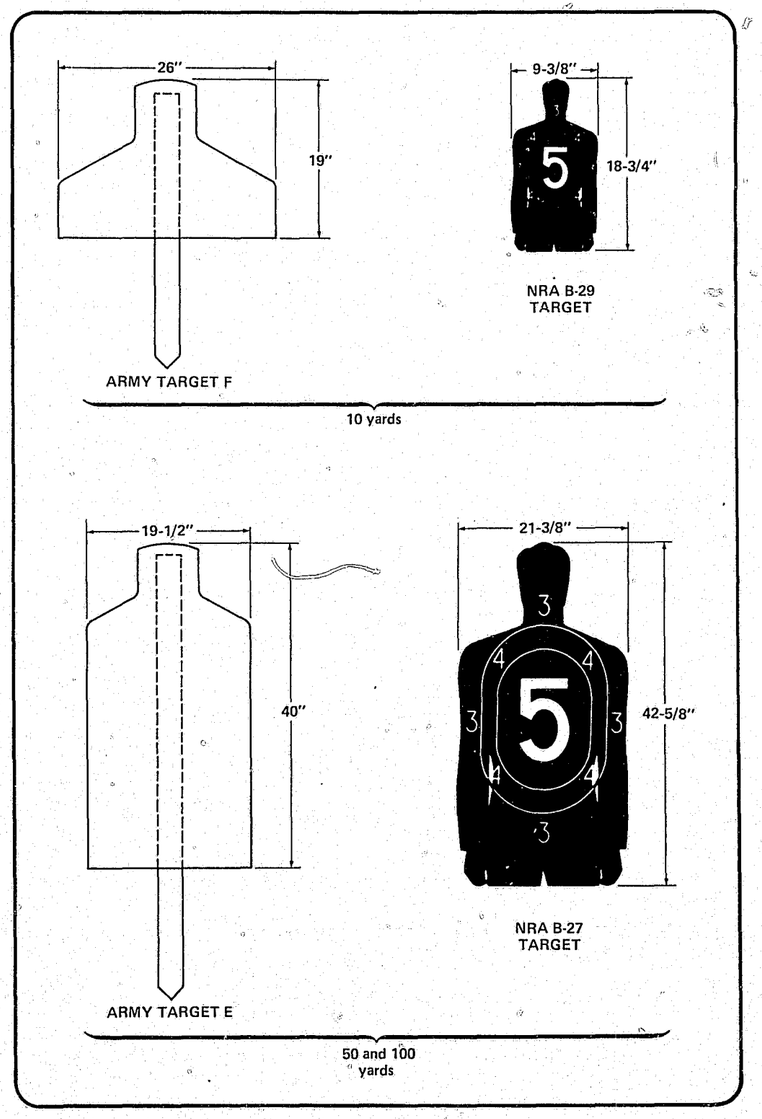
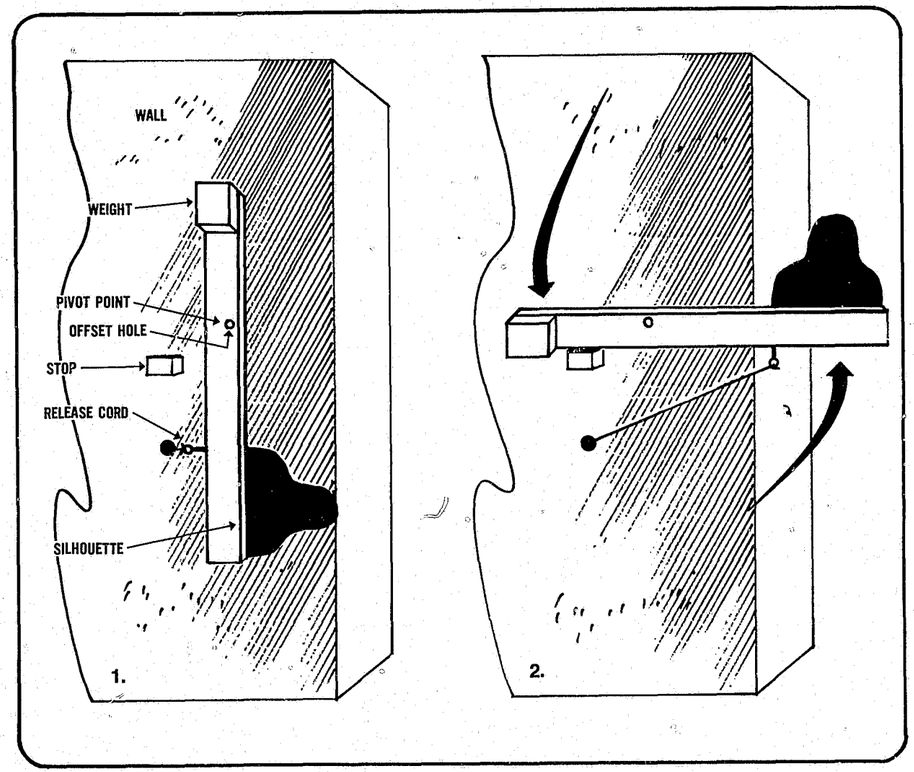


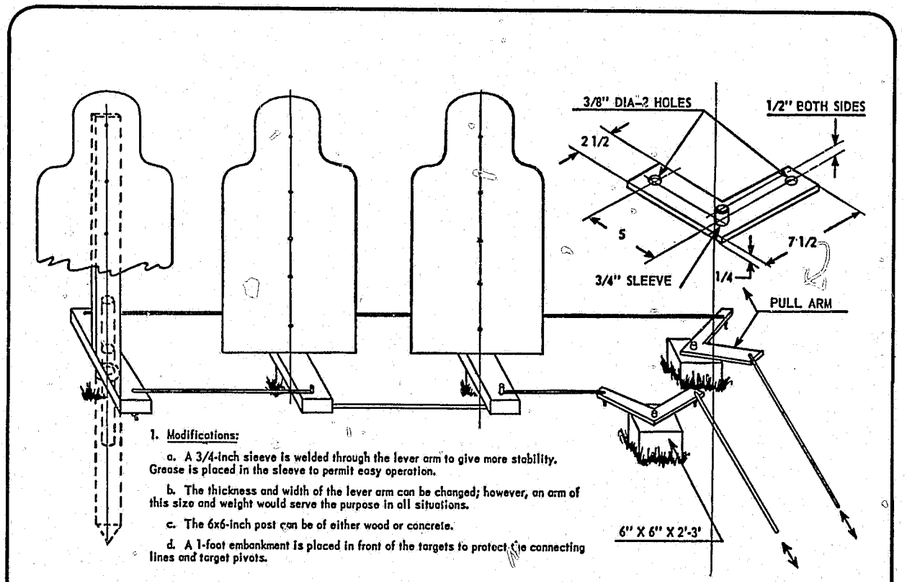
FIGURE 10
IMPROVISED BOBBING OR POP-UP TARGET



- **50 yards** – Trainee loads six rounds. On command, he assumes the shoulder position and without using the sights, fires two semiautomatic rounds at each of three targets. In this point, or "quick-kill" aiming technique, the firer looks *over* his sights at the target and if his position is correct, his shots will follow closely his line of sight.

  This aiming technique allows extremely rapid engagement of targets without the blocking of depth and movement perception that occurs when one eye is closed in sighting. Also, in night shooting, the policeman should have confidence in his ability to engage targets up to 50 yards without the use of sights. When the shooter engages multiple targets from this position, as with the hip-fire position, he should move his upper body in line with each new target. If the targets are more than a few degrees apart, he should move his entire body in order to stay in line and on balance.

FIGURE 11
PIVOT TYPE TARGETS (FM 23-31)



- **100 yards** – Trainee loads fifteen rounds. On command, he assumes the kneeling position, and using the sights, fires five semiautomatic rounds at each of three targets. Aim should be at the low middle of the targets to avoid shooting over the target and to spot hits more accurately. The firer should keep both eyes open in order to observe the location of hits and should attempt to "follow through" so that he is aware of the position of the front sight on the target at the instant the weapon fires.

The submachine gun course should be fired at least six times for instruction and once for qualification. To qualify, each officer should fire the course in the required time, achieving at least:

10 yards	Semiautomatic: 2 hits per target Automatic: 2 hits per target
50 yards	Semiautomatic: 2 hits per target Automatic: 2 hits per target
100 yards	Semiautomatic: 4 hits per target

During instructional firing, the emphasis should be upon accuracy and speed. As soon as the trainee can consistently place hits on the torso area of the silhouette, he should work for faster time before attempting to tighten up his shot groups.

The submachine gun qualification firing course recommended here may not be workable for certain weapons. For example, the trigger manipulation of the Smith and Wesson Model 76 makes two or three-shot bursts difficult, and for this weapon the National Rifle Association has developed the qualification course illustrated in Figure 12. However, any program that terminates with the trainee demonstrating less accuracy and control than that recommended herein should be considered inadequate.

Police personnel authorized to use the submachine gun should range-fire at least 100 rounds every sixty days and should fire for qualification annually. Only officers who are fully trained and qualified should be permitted to carry or fire the submachine gun in any police operation. For this reason, no "familiarization" training is provided for personnel not authorized to employ the weapon.

FIGURE 12
SUGGESTED PRACTICAL SUBMACHINE GUN QUALIFICATION COURSE FOR SMITH & WESSON MODEL 76

Prepared by
The National Rifle Association

Stage	Distance	Position	Type of Fire	No. of Rounds	Time
A	15 yards	Standing Hip Level	Full automatic	36 total 6-shot bursts 2 bursts on each of the 3 targets, *right to left*	20 sec.
B	25 yards	Standing Aim-fire from shoulder	Single fire	36 total 12 rounds single fire, 4 rounds on each of the 3 targets, *right to left*	45 sec.
		Kneeling R.H. Aim-fire from shoulder	Full automatic	12 total 4-shot bursts on each of the 3 targets, *left to right*	
		Kneeling L.H. Aim-fire from shoulder	Full automatic	12 total 4-shot bursts on each of the 3 targets, *left to right*	
C	50 yards	Standing Aim-fire from shoulder	Single fire	36 total 18 rounds single fire, 6 rounds on each of the 3 targets, *right to left*	60 sec.
		Kneeling R.H. Aim-fire from shoulder	Single fire	9 rounds single fire, 3 rounds on each of the 3 targets, *left to right*	
		Kneeling L.H. Aim-fire from shoulder	Single fire	9 rounds single fire, 3 rounds on each of the 3 targets, *right to left*	

SELECTING A POLICE SUBMACHINE GUN

For most law enforcement agencies now holding submachine guns, the acquisition rationale is either lost in departmental history or nonexistent. For example, many of the Thompsons and Reisings now residing in police armories are collectors' items. Two or three modern submachine guns can be purchased for what a Thompson cost in 1921, not to mention what the same Thompson with original parts would be worth today. Tactically, the only advantage in retaining such an expensive gun as the Thompson is the psychological deterrence of its familiar shape.

In many cases, the police submachine gun was acquired by simple confiscation from a criminal or returning serviceman. Most of the Thompsons in use today by the Chicago Police Department were reportedly seized from suspects over the years.

In any event, if a rational decision is made to arm certain police personnel with submachine guns, both domestic and foreign weapons should be evaluated in order to select the submachine gun most suited to police requirements. It should be noted that most excellent submachine guns are manufactured outside the United States. This is primarily because the U.S. Army has not had a standard submachine gun since the M3A1 "grease gun" developed during World War II.

Evaluation Criteria

For use in police work, a submachine gun should be evaluated on at least the following basic criteria:[3]

1. **The magazine should fit easily into the gun.** A good arrangement is utilized in the Israeli Uzi and the Czech ZK476, in which the magazine feeds through the pistol grip. This makes it easy to insert the magazine in the dark just by joining hands. A poor arrangement is found on the Thompson M1A1 in which the weapon must be taken from the shoulder and turned on its right side so that the right hand can release the magazine release lever, while the left hand feeds the magazine in a manner that will allow a ridge on its back edge to engage a slot behind the magazine well.

2. **The magazine should be capable of being loaded without tools.** This criterion is met by most submachine guns but some have sharp projections on the follower lips that make them more difficult to load than others. A very strong magazine follower spring can also increase the difficulty of hand-loading cartridges without the use of a metal device that depresses the magazine follower while the cartridges are inserted.

3. **The stock should retract or fold for compactness and concealability.** This feature is important for carrying the weapon under plain clothes or in vehicles.

4. **The submachine gun should be able to withstand prolonged usage without cleaning.** This capability gives the modern submachine gun more reliability in sustained automatic fire than some automatic rifles.

[3] The first ten recommended evaluation criteria are adapted from those listed in Thomas B. Nelson's *The World's Submachine Guns* and are used with the author's permission.

5. **Ammunition should be readily available and standardized.** A police department should not stock weapons for which large emergency supplies of ammunition are not available.

6. **Ammunition should be lightweight and inexpensive.** The Thompson, Reising, and Ingram Model 6 are all chambered for the .45 caliber a.c.p. ammunition which is available in large stocks of U.S. Army surplus. Unfortunately, the .45 caliber weapons and their ammunition are considerably heavier than their 9 mm counterparts. However, 9 mm ammunition can be inexpensively obtained in quantity from Europe and the British Commonwealth, where the round is the standard military pistol and submachine gun cartridge. Importers can supply the necessary quantities of ammunition, but noncorrosive brands, such as Finnish "Lapua," should be specified. Corrosive primers used in some European ammunition will cause pitting of the barrel unless the weapon is cleaned thoroughly, immediately after use.

7. **The weapon should be lightweight.** It should not weigh over nine pounds unloaded. Optimally, its weight should approach six pounds. Its ammunition should not disproportionately increase its weight. For instance, a man can carry twice as much 9 mm ammunition by weight as he can .45 caliber a.c.p., although this consideration is not as important in police work as in the military since the policeman is not carrying an existence load as well as a combat load.

8. **The cost of the submachine gun should be low,** both to produce and to purchase. Rapid production techniques should be employed, including extensive use of stamped parts. Simplicity, reliability, ruggedness, and short-range accuracy should be the goals of design and manufacture.

9. **The weapon should possess a manual safety** and, optimally, a grip safety so that the gun will not fire if dropped. The grip safety should be automatically depressed when the firing hand is in position.

10. **The retracting handle for the bolt should be on top or on the left side of the receiver.** This allows a right-handed man to keep the weapon in firing position while cocking the piece or applying immediate action in case of stoppage.

11. **The safety should be clearly marked and accessible by quick feel.** The safety position and fire selector positions should be engraved with letters on the receiver and the letters filled with bright enamel paint.

12. **The safety and the fire selector should be incorporated in the same switch.** This switch should be accessible while the shooter's master hand remains on the pistol grip in firing position. If possible, there should be two connected switches, one on either side of the stock, with all safe and fire positions, for use by left as well as right-handed shooters.

13. **The ejection angle of spent cartridges should not interfere with use of the weapon from left-handed or underarm positions.** This interference could occur for left-handed shooters if the cartridges were ejected rearward, or even at a 90-degree angle in some short-stock models. If ejected directly upward, the hot cartridges might strike the face of a shooter firing a short-stock weapon from the hip. If the ejection port were on the bottom of the gun, a shooter firing from the prone position might find himself lying in a pile of hot shell cases, The best direction would seem to be forward from a right side ejection port at a 45-degree angle to the gun barrel.

14. **The submachine gun should have a straight-line shoulder stock.** In both fixed-stock and folding-stock versions a straight-line stock will dampen the upward movement of the barrel on full automatic fire. The straight-line stock should also make it easier to see the sights quickly and to point-fire the weapon accurately without the use of the sights.[4]

15. **A low cyclic rate of fire is preferable for accuracy and controllability in full automatic bursts.** Preferably, for police use, the cyclic rate should not exceed 700 rounds per minute.

16. **The weapon should utilize a box-type magazine.** The box magazine is less likely to cause feeding problems than the drum-type. The magazine should hold at least twenty, preferably thirty, cartridges.

17. **The submachine gun should be equipped with a canvas web sling.** The sling should be attached on the left side of the weapon so that it can be carried around the neck or over the shoulder in the assault-fire position. This allows the weapon to be ready for instant use while freeing the shooter's hands.[5]

18. **The front sight should be a post-type protected by a hood or wings.** The rear sight should be an aperture-type, adjustable to 200 meters and protected by wings. The rear sight should be in position for instant use, not a flip-up leaf-type like that of the 1921 Thompson.

19. **The weapon should fire from the open-bolt position.** For carefully aimed semiautomatic fire, the closed-bolt position used in some submachine guns is more accurate due to a faster lock-time. However, the open-bolt position is more reliable since its firing pin hits the primer more solidly with the weight of the bolt behind it.[6] Also, when the open-bolt is closed, the weapon can be seen to be safe, and when it is open, the ammunition is clearly visible. In some submachine guns the closed open-bolt serves as an effective dust-cover even under desert conditions. The open-bolt design is simpler, with fewer moving parts than the closed-bolt design. With constant firing, some closed-bolt actions are subject to "cook-off," in which the heat of the bolt face is sufficient to set off a cartridge.

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[4] In the 19th Century, shoulder stocks angled downward sharply from the direction of the barrel. Modern full automatic rifles and light machine guns make extensive use of the recoil-dampening effects of the straight-line stock; for example, the M16A1 rifle and the M60 machine gun used in the U.S. Army.

[5] A specially designed holster should be used for carrying the submachine gun concealed under plain clothes. Seventrees Limited of New York City has manufactured special holsters for the Israeli Uzi and the Ingram Model 11. Similar holsters can be made for the Heckler & Koch MP5, the Walther MPK, and any other compact, lightweight submachine gun.

[6] "Open-bolt" action means that when the weapon is cocked the bolt remains open. When the trigger is pressed the entire bolt moves forward, stripping a round from the magazine into the chamber, and striking the cartridge primer by means of a firing pin machined on the bolt face. "Closed-bolt" action means that the weapon is cocked by drawing the bolt to the rear and releasing it, stripping a cartridge into the chamber. When the trigger is pressed it releases a cocked hammer which strikes a firing pin, setting off the cartridge. The release of a cocked hammer is faster and less jarring to the shooter's aim than the travel of an open-bolt from its rearward position.

To illustrate the application of the 19 evaluation criteria, ten submachine guns, listed in figure 13, were examined and test fired. The results are summarized in figure 14 and described in the following sections. Of the evaluated weapons, those which are available for purchase are listed below and may be obtained from the suppliers indicated.

Heckler & Koch MP5A3
Security Arms Company
Suite 1004
1815 Fort Myer Drive
Arlington, Virginia 22209

Ingram Models 10 and 11
Military Armament Corporation
Powder Springs, Georgia 30073

Smith & Wesson M76
Smith & Wesson, Incorporated
Springfield, Massachusetts 01101

Thompson M1928
Numrich Arms Corporation
West Hurley, New York

Walther MPK and I.M.I. Uzi
Interarms
10 Prince Street
Alexandria, Virginia

Domestic Submachine Guns

Thompson M1A1. The test gun of the Thompson series was the Army issue M1A1. This weapon differs somewhat from the original 1921 Thompson, shown in figure 15. For example, the cocking handle is on the right side rather than on the top as in the 1921 model. It does not have the ribbed barrel or the Cutts compensator, which is an improvement since neither of these characteristics of the 1921 model was effective or necessary. Its wooden stock is not detachable, unlike that of the 1921 Thompson. This is not a significant handicap for portability considering the normal bulk of the Thompson barrel and receiver assembly.

The M1A1's rear sight wings are triangular rather than rectangular, to compensate for the greater height of its fixed 100-yard aperture sight. The 1921 Thompson has a folding leaf sight that in its downward position exposes a "combat" open sight. In its upward position, the leaf provides a vertical ramp for an aperture sight that slides up and down for elevation adjustment, with a screw for windage adjustment.[7] The M1A1 has a conventional forearm rather than a forward handgrip. Finally, the M1A1 is equipped with box-type magazines, not drum magazines as is the Model 1921.

The M1A1 is difficult to load. The magazine release must be pressed to insert as well as remove magazines. The magazine release lever is so far forward that, unless the shooter has very long thumbs, this release must be actuated by moving the right hand to the left of the handgrip, after removing the weapon from the shoulder. It may be possible to actuate the release with the left hand holding the magazine, but usually the left hand is occupied in getting the ridge in the back of the magazine into the groove behind the magazine well.

[7]This 1921 sight looks remarkably effective but the combat sight is often considerably off in elevation, and the aperture sight tends to slide down the ramp of its own accord. Also, the ramp is vulnerable to falls because the leaf extends well above the wing guards.

	Manufacturer	Country of Origin	Caliber	Operation	Type of Fire	Weight unloaded (pounds)	Length with Stock (inches)	Barrel Length (inches)	Cyclic Rate of Fire (r.p.m.)	Magazine Type & Capacity	Sights F = Front R = Rear	Minimum Muzzle Velocity Commercial Ammunition (feet per second)
Thompson M1A1	Auto-Ordnance Corp.	U.S.A.	.45 a.c.p.	Blowback	Full & Semi	10.45	32	10.5	700	Box 20, 30	F: Fixed Post R: Fixed 100-yard aperture	850 (.45 a.c.p.)
Reising M50	Harrington & Richardson	U.S.A.	.45 a.c.p.	Delayed Blowback	Full & Semi	6.75	35.75	11	550	Box 12, 20	F: Fixed Post R: Adjustable aperture 50-300 yards	850
U.S. M3A1	Ithaca Gun Co.	U.S.A.	.45 a.c.p. 9 mm parabellum	Blowback	Full	8.15	29.8	8	350-450	Box 30	F: Fixed Post R: Fixed 100-yard aperture	850
Ingram M6	Police Ordnance Company	U.S.A.	.45 a.c.p. 9 mm parabellum .38 super auto	Blowback	Full & Semi	7.25	30	9	600	Box 30	F: Fixed Post R: Fixed 100-yard aperture	850 (.45 a.c.p.) 1120 (9 mm) 1280 (.38 super)
Ingram M10	Military Armament Corporation	U.S.A.	.45 a.c.p 9 mm parabellum	Blowback	Full & Semi	6.25	21	6	700	Box 30, 32, 36	F: Windage Adjustable Post R: Fixed 100-meter aperture	850 1120
Ingram M11	Military Armament Corporation	U.S.A.	9 mm Kurz (.38 a.c.p.)	Blowback	Full & Semi	3.5	18	5	850	Box 16, 32	F: Windage Adjustable Post R: Fixed 50-meter aperture	955 (.380 a.c.p.)
Smith & Wesson Model 76	Smith & Wesson	U.S.A.	9 mm parabellum	Blowback	Full & Semi	7.25	30.5	8	720	Box 36	F: Fixed Post R: Fixed 100-yard aperture	1120
Heckler & Koch MP5A3	Heckler & Koch	West Germany	9 mm parabellum	Delayed Blowback	Full, Semi, & 3-Round Burst	5.6	25.98	8.85	650	Box 30	F: Fixed Post R: Rotary Adjustable	1120
Walther MPK	Walther	West Germany	9 mm parabellum	Blowback	Full & Semi	6.2	25.96	6.75	550	Box 32	F: Fixed Post R: 75-meter notch and 125-meter aperture	1120
I.M.I. Uzi	Israeli Military Industries	Israel	9 mm parabellum	Blowback	Full & Semi	7.7	25.20	10.2	650	Box 25, 32, 40	F: Adjustable Post R: "L" aperture 100 & 200 meter	1120

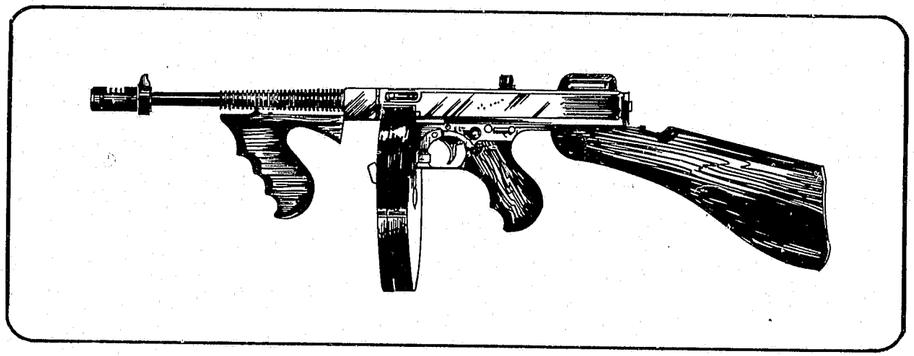
FIGURE 13
CHARACTERISTICS OF TEN SELECTED
SUBMACHINE GUNS

Criteria	Magazine fits easily into gun	Magazine can be loaded without tools	Folding Stock	Reliability without cleaning	Ammunition widely available	Ammunition light weight	Safety	Cost	Cocking handle position	Weapon light weight	Thumb safety easily accessible	Safety and fire selector one switch	Ejection Angle	Angle of Stock to Bore	Cyclic rate less than 700 r.p.m.	Box clip at least 20 rd.	Sling on left side	Protected adjustable sights	Bolt at time of firing
Thompson M1A1	Poor	Yes	No	Fair	Commercial and Military	.45 a.c.p. cartridge wt. 20.9 grams	Manual	No longer for civilian sale	Right	10.45 lb.	No	Two	Right Side	Poor	700	20, 30	Bottom	Protected Fixed	Open
Reising M50	Fair	Yes	No	Poor	C & M	20.9	Manual	No longer sold	Bottom	6.75 lb.	Yes	One	Right Side	Poor	550	12, 20	Right	Unprotected Adjustable	Closed
U.S. M3A1	Good	Yes	Yes	Good	C & M	20.9	None	Not for civilian sale	Right	8.15 lb.	None	None	Right Side	Good	450	30	Left	Unprotected Fixed	Open
Ingram M6	Poor*	Yes	No	Fair	C & M	20.9	Manual	No longer sold	Right	7.25 lb.	Yes	One	Right Side	Fair	600	30	Bottom	Unprotected Fixed	Open
Ingram M10	Good	Yes	Yes	Unknown	C & M	9 mm cartridge wt. 11.8 grams	Manual	Not yet available	Top	6.25 lb.	No	Two	Right Side	Poor	700	30, 32, 36	Left	Unprotected Fixed	Open
Ingram M11	Good	Yes	Yes	Unknown	Commercial only	.380 a.c.p. cartridge wt. 9.4 grams	Manual	Not yet available	Top	3.5 lb.	No	Two	Right Side	Poor	850	16, 32	Left	Unprotected Fixed	Open
Smith & Wesson Model 76	Good	Yes	Yes	Fair	C & M	11.8	Manual	$73.44	Right	7.25 lb.	No	One	Right Side	Good	720	36	Left	Protected Fixed	Open
Heckler & Koch MP5A3	Good	Yes	Yes	Good	C & M	11.8	Manual	Not yet available	Left	5.6 lb.	Yes	One	Right Side	Good	650	30	Left	Protected Adjustable	Closed
Walther MPK	Good	Yes	Yes	Good	C & M	11.8	Manual	$125	Left	6.2 lb.	Yes	One	Right Side	Good	550	32	Left	Protected Adjustable	Open
I.M.I. Uzi	Good	Yes	Yes	Good	C & M	11.8	Manual + bolt + grip	$125	Top	7.7 lb.	Yes	One	Right Side	Good	650	25, 32, 40	Left	Protected Adjustable	Open

*The Ingram M6 magazine will fit into the gun backward.

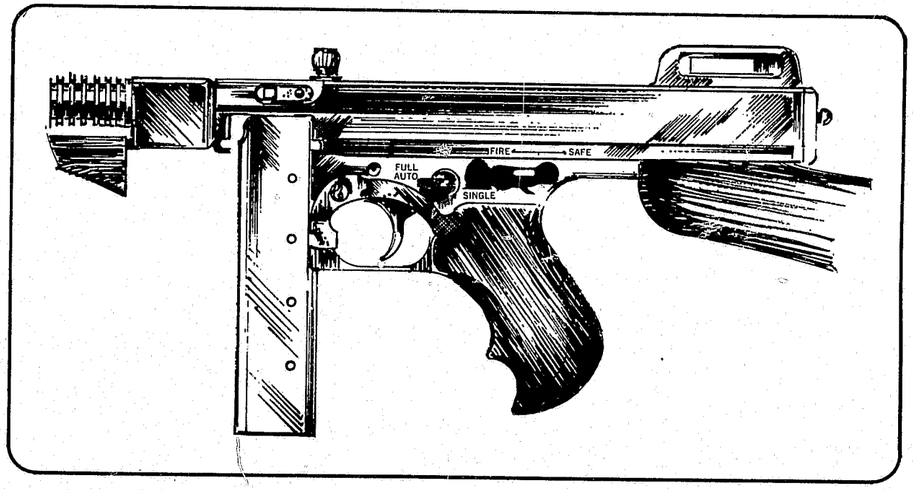
FIGURE 14
COMPARISON OF NINETEEN CHARACTERISTICS
OF TEN SELECTED SUBMACHINE GUNS

FIGURE 15
EARLY MODEL 1921 THOMPSON SUBMACHINE GUN



The Thompson firer can select full automatic or semiautomatic fire with a lever near the magazine release, as shown in figure 16. He should then put the weapon on safe with another lever near the fire selector. At this time, he can reach on the other side of the weapon and retract the bolt handle for firing. If he then wishes to shoot he can reach around with his thumb and put the safety lever into the "fire" position.

FIGURE 16
THOMPSON MODEL 1928A1



The Thompson has a heavy butt which is attached at a steep angle from under the rear of the receiver. This butt adds to the weight of the weapon (10.45 pounds unloaded). However, because of its angle to the bore, it does not significantly dampen the muzzle climb.

The M1A1's cyclic rate of fire is around 700 rounds per minute, which is not excessive for good controllability. It has a heavy trigger pull, and fires regular .45 caliber a.c.p. pistol ammunition, ball or tracer. There is no question about the manstopping ability of this cartridge, although it does not have the flat trajectory, penetration, or light weight of the 9 mm parabellum cartridge.

The M1A1 is 32 inches long. Its recoil is negligible due to its weight and straight blowback operation.

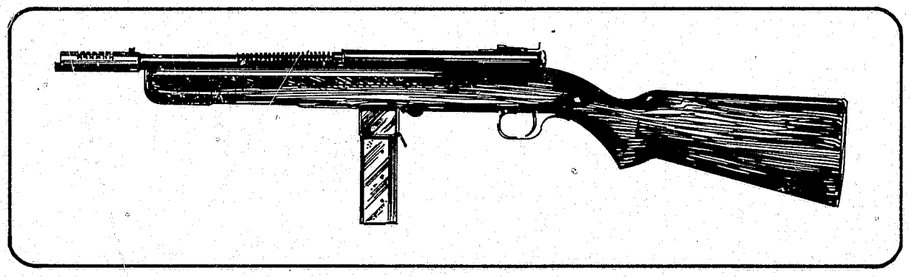
Commercial Thompson submachine guns are now available only from Numrich Arms Corporation in West Hurley, New York. This organization superseded Auto Ordnance Company, the original manufacturer. The current list price for the Model 1928 is $295.

Reising M50. Harrington and Richardson in Worchester, Massachusetts, produced Reising submachine guns from 1941 to 1945. Approximately 100,000 guns were produced and most of the production went to the U.S. Marine Corps. Its lack of reliability and interchangeable parts caused its discontinuation as a military weapon. Since then, a number of M50, M55, and M60 Reisings have been acquired by some police departments. In police work the accuracy of the weapon's closed-bolt action can be an asset.

This weapon, illustrated in figure 17, utilizes a standard rifle stock, which is not particularly adapted to full automatic fire because of its angle to the bore. The weapon itself is quite light, 6.75 pounds unloaded. Its lightness, combined with its angle stock and its full power .45 caliber a.c.p. cartridge, make the weapon difficult to control in full automatic fire. It has a very rapid muzzle climb, in spite of its low cyclic rate of fire (550 r.p.m.).

The M50 is comparatively accurate in semiautomatic fire due to its light trigger pull, its closed-bolt fire position, and its adjustable aperture rear sight. The safety and selector are contained in one switch on the right side of the receiver. The switch is not easily activated from the shoulder position, but when the weapon is held low, as in the hip-fire position, the switch is quite convenient.

FIGURE 17
H&R REISING M50 SMG



The magazine well construction is rather crude. A stud on the magazine locks into a hole in the well. A piece of sheet metal holds the magazine in position and is pulled to release it. Magazines can be obtained that hold 12 or 20 rounds.

The cocking lever is in a groove under the forearm. A finger is placed in the slot to draw the lever to the rear. This must be done in a sharp motion since riding the lever forward may cause a closed-bolt weapon to fail to lock, resulting in faulty ignition, misfires, or hangfires and/or faulty extraction.

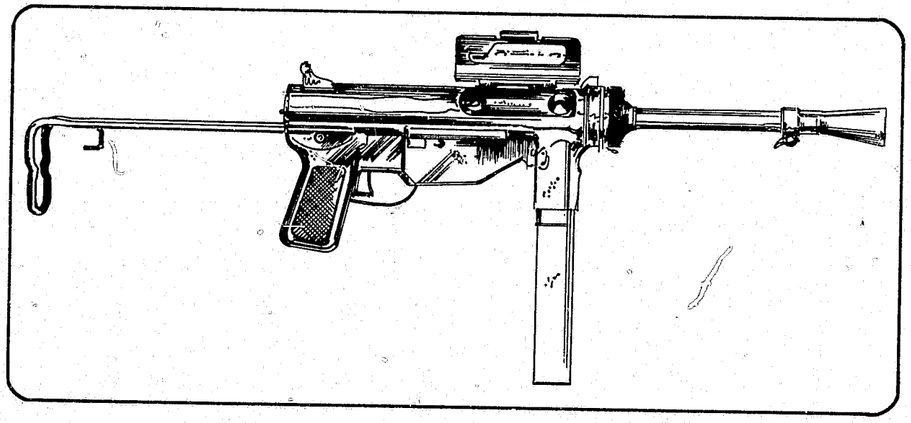
The Reising can be obtained with a sling attached to its right side. The right side position is better than an underside attachment since in the former position the clip will not bang against the gunner's back. Still, the position, except for left-handed shooters, is inferior to the left-side attachment.

M3A1 "Grease gun". The M3 was the first American submachine gun to make extensive use of sheet metal stampings and modern methods of manufacture. It replaced the Thompson as the U.S. military standard. The M3 was designed in 1941 and was later produced by Guide Lamp Division of General Motors and the Ithaca Gun Company.

The M3A1, shown in figure 18, differs from the M3 in several minor details. The most obvious differences are the enlarged ejection port and cover on the M3A1 and the cocking slot located in the bolt itself rather than externally.

The M3A1 is noted for its reliability. With its ejection port cover closed and its barrel plugged, it is virtually impervious to sand, mud, and moisture. Its loose tolerances allow it to function reliably even when a fair amount of mud or sand finds its way into the action. The M3A1 is about two pounds overweight by modern standards, uses the heavy .45 caliber a.c.p. cartridge, and has no

FIGURE 18
U.S. M3A1 SUBMACHINE GUN



thumb safety or semiautomatic selector, but is still one of the best submachine guns in the world today. Copies have been manufactured in Argentina, Nationalist China, Japan, Communist China, and North Vietnam. Its principal virtues are ruggedness and full automatic controllability.

This weapon is not currently available to U.S. police. Most of those produced have been going to military allies in the "third world." In these countries, South Korea for example, it is commonplace to see police as well as the military equipped with M3A1's. Of course, the paramilitary aspects of police work are more pronounced in these countries than in the United States.

The only safety on the M3A1 is the ejection port cover which, when closed, locks the bolt to the rear when the weapon is cocked. The bolt in its forward position serves as a second kind of safety. With practice, opening the cover with the left hand could become as fast or faster than flicking off the thumb safety on many submachine guns. Unless actually in combat, the weapon should be carried "bolt closed/cover open" or "bolt open/cover closed." The M3A1 can be readied easily from either position with the left hand while the right remains in firing position.

The M3A1 is gripped with the left hand holding the magazine. Such a forward handgrip can be pulled rearward as well as downward, an advantage in controlling full automatic fire. The barrel itself becomes very hot and cannot be gripped or touched while shooting.

Single shots can be obtained by quick-releasing the trigger, but the weapon's real advantage is its slow rate of fire which allows short, accurate bursts. First-round hits can be obtained by knowing how far off the crude sights are at various ranges. Second and third-round hits are not difficult since the M3A1 tends to recoil straight back and up. At close range the low cyclic rate of fire permits a trained man to keep an entire clip of 30 rounds on a man-size silhouette target.

Of course, in combat the usual shooting method is instinctive pointing, spotting the hit, and walking the bullets on target, but for U.S. police the objective is always a first-round hit. Suppressive fire is generally not appropriate in urban surroundings. Consequently, for police work the M3A1 with its crude sights and lack of semiautomatic capability would offer no advantage over the Thompson and Reising.

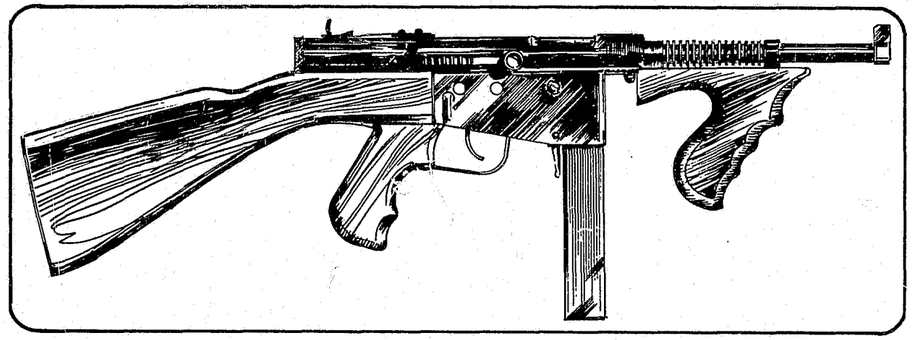
Ingram Model 6. The Ingram Model 6 SMG is a popular weapon in U.S. police departments, though not on a scale with the Thompson or the Reising. In appearance, the Model 6, illustrated in figure 19, resembles a simplified Thompson. The stock-to-barrel angle is similar to the Thompson's and is not a good design for automatic fire.

An unloaded Model 6 weighs 7.25 pounds and is two inches shorter than the Thompson. The sling on the military version is located on the bottom of the fixed shoulder stock. The rear sight is an adjustable aperture without protecting wings; the military version has a fixed 100-yard aperture.

The Model 6, designed by Gordon Ingram, was marketed in 1949 by Police Ordnance Company of Los Angeles, California. Model 6's were chambered to fire either .45 a.c.p. or 9 mm ammunition from the open-bolt position. The later Model 7 was designed to fire the Colt super .38 automatic cartridge from the closed-bolt position.

A selector switch and the bolt retracting handle are located on the right side of the weapon. The selector has the usual safe, semiautomatic, and automatic positions. In addition to the thumb

FIGURE 19
INGRAM MODEL 6 .45 a.c.p. SUBMACHINE GUN



safety, the Model 6 has a safety notch at the rear of the bolt retracting slot that can be used to lock the retracting handle.

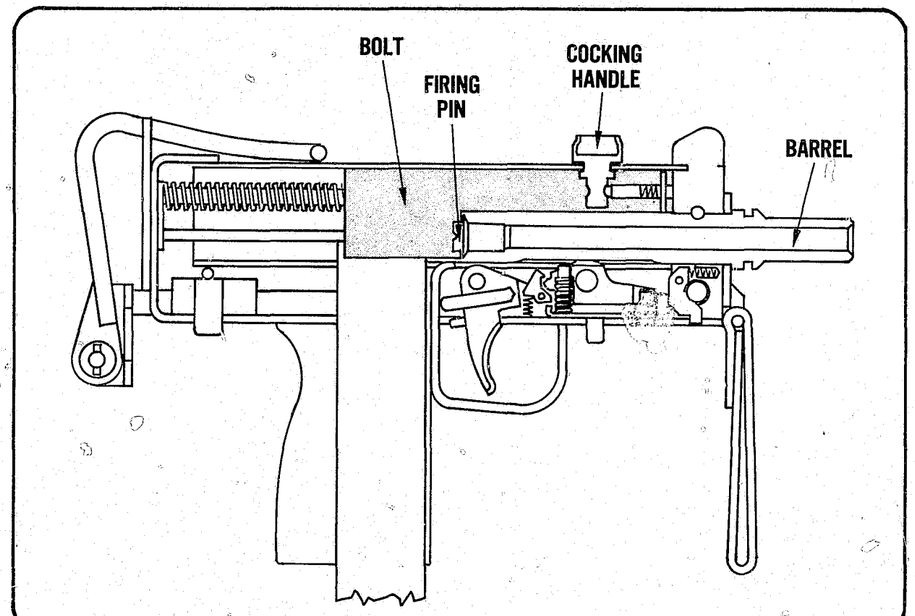
A two-stage trigger was built into the automatic fire mechanism of the Model 6. When the selector is placed on automatic and the trigger pressed, the first position the trigger comes to will fire single shots. When the trigger is pulled all the way to the rear, the gun will fire automatic. A great amount of pressure is needed to pull the trigger to the rear, making consistent 2 and 3-round bursts almost impossible. The usual four-or-more-shot bursts are disconcertingly interspersed with semiautomatic single shots.

The 30-round box magazine for the Model 6 is easy to load without tools, and it is easily fitted into or taken out of the gun. However, the firer must use care in loading the magazine since the cartridges can be accidentally loaded backward.

Ingram Models 10 and 11. These weapons are prototypes of the modern trend in submachine gun design. This trend is toward a real "machine pistol" whose basic unit is no larger than a service pistol. The firepower and handling characteristics of this type of weapon are far superior to those of a conventional pistol. The Czech Model 61 "Scorpion" and the Soviet "Stechkin" are examples of pistol-size submachine guns.

This type of weapon must have a design which is small and lightweight, yet controllable on full automatic fire. Although a light weapon climbs with recoil faster than a heavy one, there are several ways of offsetting this tendency. One such method is to design the weapons with a heavy bolt that telescopes around the barrel. The Model 11 Ingram submachine shown in figure 20 illustrates this approach. This design is also carried out in the Czech 61, the Israeli Uzi, the Beretta Model 12, and the Ingram M10. The Mauser Model 57 (not covered in this bulletin) and the Ingram models 10 and 11 have a collapsible forward handgrip. The Czech 61 has the recoil buffer in its handgrip. A muzzle compensator can be attached for control of full automatic fire. A straight-line collapsible or retractable buttstock can be employed. Finally, a cartridge or a powder-loading can be used to reduce the cyclic rate of fire.

FIGURE 20
CUT-AWAY VIEW OF INGRAM M-11 SHOWING TELESCOPING OPEN-BOLT SYSTEM

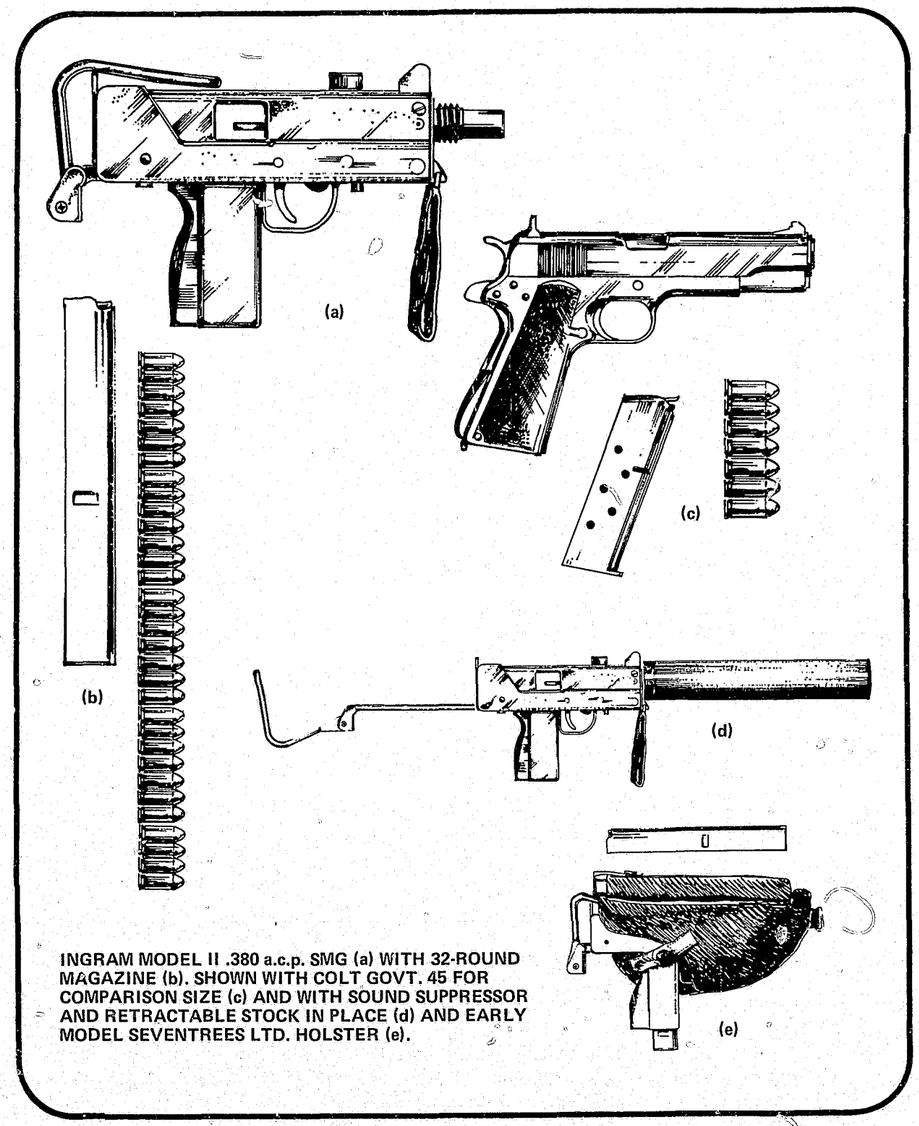


The Ingram Model 10 weighs 6.25 pounds and is chambered for .45 caliber a.c.p. or 9 mm parabellum. It is 10.5 inches long without stock and fires at a rate of 700 rounds per minute. The Model 11 is chambered for the .380 a.c.p. cartridge; it weighs only 3.5 pounds and is 8.75 inches long without stock, but it fires 850 rounds per minute.

The sound suppressors for these guns are probably the best "silencers" on the world market. The only sound from the .380 a.c.p. Model 11 and the .45 a.c.p. Model 10 is the bolt moving back and forth and the bullet striking the target. Two problems with other types of sound suppressors are the limited life of the suppressor itself from bullets passing through it, and overheating caused by the recycling of powder gases within it. The suppressors for the Ingram 10 and 11 have an indefinite life span, and a neoprene sleeve around the suppressor allows the shooter to grasp the suppressor with his left hand for extensive firing. The suppressor, which screws onto the barrel, makes a stable handgrip, particularly for hip-firing. The Ingram Model 10, and the Model 11 shown in figure 21, also have a web-strap foregrip for use when the sound suppressor is not attached.

The prototype buttstock is not adequate when used from the shoulder. If a submachine gun cannot be used from the shoulder, it can only be hand-fired like a pistol or fired from the hip. The M10 and M11 prototypes have aperture sights rather than open sights which makes pistol-type

FIGURE 21
INGRAM MODEL 11 .380 a.c.p.



INGRAM MODEL II .380 a.c.p. SMG (a) WITH 32-ROUND MAGAZINE (b). SHOWN WITH COLT GOVT. 45 FOR COMPARISON SIZE (c) AND WITH SOUND SUPPRESSOR AND RETRACTABLE STOCK IN PLACE (d) AND EARLY MODEL SEVENTREES LTD. HOLSTER (e).

shooting inaccurate since the hole through the rear sight cannot be seen at arm's length. When the weapon is fired from the hip, even with a sound suppressor attached, the high cyclic rate of fire makes short accurate bursts difficult.

The high cyclic rate of fire is still a matter of controversy among designers. Soviet designers feel that in modern warfare a very high cyclic rate is necessary and desirable for suppressive fire. Many think that the 450 r.p.m. cyclic rate of the M3A1 is too sluggish. About 700 rounds per minute is considered a maximum for police use, because this rate seems to be the upper limit for accurate short-burst fire on single point targets by a moderately trained shooter. U.S. police are not generally concerned with suppressive area fire as employed by troops in the assault. Both the Ingram Model 10 and the Model 11 tend to fire greater bursts than the three-round maximum desirable for police work.

On the original M10 and M11, the safety and the fire selector were underneath the front of the receiver and easily accessible to the shooter's firing hand. In later models, however, the full and semiautomatic switch is found on the left side of the receiver. The location of the fire selector away from the safety lever makes the weapon slower to operate.

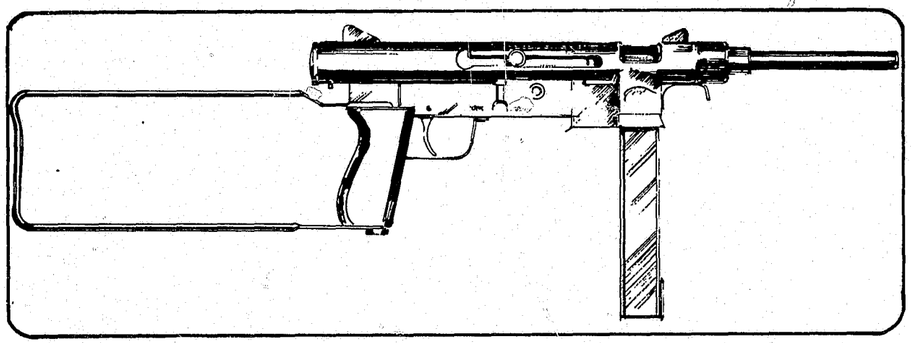
The retractable stock is a serious defect in the design of the prototype. It wobbles back and forth when placed against the shoulder, and because it is set at an awkward angle to the base, the shooter cannot rapidly see the sights. The stock was originally intended merely to steady the weapon when held against the body during hip-fire.

The current forms of the Ingram Models 10 and 11 have great potential for various modern military purposes such as clandestine raids, assassination, and as a sidearm for tank and helicopter crew members, engineers, artillerymen, officers, and N.C.O.'s. For police work, a special model could be equipped with a sturdy, detachable, wire shoulder-stock that could be carried in a shoulder rig on the opposite side of the gun holster. The weapon could also be used as a pistol with the addition of an open rear sight. With a sturdy buttstock the Ingram models are surprisingly accurate. Experimentally, an improvised wooden stock was fitted to a "suppressed" Model 11, and it was not too difficult to hit man-size targets at 100 yards using semiautomatic fire.

Smith & Wesson M76. Smith & Wesson, a subsidiary of Bangor Punta, introduced the M76 submachine gun in 1967. The M76 fires 9 mm ammunition at 720 rounds per minute. With stock folded the S&W measures 20.25 inches. The M76, shown in figure 22, weighs 7.25 pounds and is more portable than the 10.45-pound Thompson. At $73.45, the M76 costs less than the $295 Thompson.

This weapon uses the Carl Gustav-type magazine. Three M76 magazines were supplied with the test gun. Two of the three magazines were extremely difficult to load due to very heavy magazine follower springs. The heavy springs, combined with the sharp magazine lips, made loading beyond the fifteenth round quite difficult. If the stiff spring and sharp magazine lips are necessary for proper functioning, the manufacturer might consider including a loading tool with his guns. Jamming in submachine guns is most often due to faulty magazines. Four stoppages occurred during test firing with one of the three magazines; the other two magazines were reliable.

FIGURE 22
SMITH AND WESSON MODEL 76 9 mm SMG



The M76 has crude fixed sights. The rear sight is a simple protected aperture, and the front sight is a piece of metal pried up from the sight base to form a post protected by wings. These sights are adequate for short range shooting. The stock is made of plastic coated metal which is an advantage in cold weather to protect the cheek from contacting metal. The stock folds on the left side of the weapon. Open, the stock lengthens the M76 to 30.5 inches as compared with 32 inches for the Thompson or 25.2 inches for the Uzi. The stock is well designed with a straight-line configuration. Sling mounting slots are located on the left side of the weapon.

The bolt retracting handle, which is located on the right side, moves with the bolt in firing. There are longitudinal grooves inside the receiver to collect dirt from around the bolt.

The selector lever can be operated from either side of the gun, but is located halfway down the receiver from the normal thumb position. The heavy trigger pull causes the M76 to lose considerable accuracy.

Once the shooter has applied the force necessary to pull the trigger for full automatic fire, it is difficult to disengage rapidly. Consequently, when two and three-round bursts are attempted, four and five-round bursts are consistently produced. As with most submachine guns, the M76 climbs high-right, which means that if the first round is on target, successive rounds will go progressively off target with a round-to-round dispersion that increases with range. Thus, short bursts are required for accuracy and ammunition conservation.

The M76 takes advantage of several design ideas that have been current in Western Europe since World War II. It is easily manufactured, making extensive use of metal stampings, and fires the 9 mm parabellum round which is standard in NATO countries. The general configuration is most like the Swedish "Carl Gustav" or the Egyptian "Port Said." The design is not particularly compact, but it is better in that respect than a Thompson or a Reising. On the other hand, the M76 is not as compact, accurate, or reliable as the Uzi or the Walther MPK. Its biggest advantage is price. At $73.45, the M76 costs only 3/5 the imported price of the Uzi or an MPK.

Foreign Submachine Guns

Heckler & Koch MP5. The MP5 submachine gun is produced by Heckler and Koch of Oberndorf, West Germany. It is a 9 mm parabellum scaled-down version of the 7.62 mm G3 assault rifle. The G3 is one of the world's best assault rifles and is sold in Germany, Portugal, Norway, Sweden, Denmark, Pakistan, and the Dominican Republic. Both weapons work on a roller-retarded, delayed-blowback, closed-bolt mechanism. Some 63 percent of the parts of the 9 mm MP5 interchange with G3 parts and another 20 percent are practically identical.

A selector lever is located above the MP5 pistol grip with positions marked F for full, E for semi, and S for safe. The latest version, the MP5A3, is marked with the international symbols: O for safe, 1 for semi, 30 for full, and 3 for 3-shot burst. The last symbol represents a revolutionary development in submachine gun design. Currently, only a handful of European assault rifles and the American-made Special Purpose Individual Weapon (S.P.I.W.) developed by the A.A.I. Corporation have the capability of firing three-shot bursts automatically. Since a large part of submachine gun training is conditioning men to fire short bursts, this option on the MP5 should prove quite valuable. In spite of the 4 positions, the selector lever shifts easily down from the "safe" position to the "3-shot" position with only a short movement of the shooter's thumb.

The MP5 cocking handle is on the upper left side of the receiver. As with any closed-bolt weapon, the shooter should remember not to ride the handle forward in cocking, but to let the bolt slam shut for positive locking.

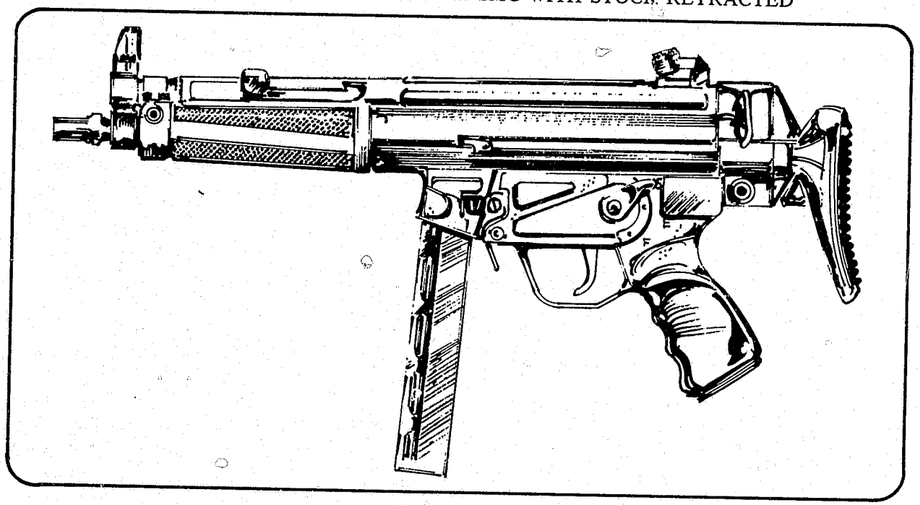
A rigid buttstock is standard on the MP5. The MP5A1, illustrated in figure 23, is the paratroop model with retractable buttstock, and the MP5A3 is a variation of the latter. The sling attaches on the left side and can be adjusted to accommodate several combat sling carrying positions. For carrying the weapon concealed, a retractable stock model with sling attached is recommended.

The MP5, like most modern submachine guns, is made primarily of metal stampings. The sights are protected blade front and aperture rear. The rear sight is of rotary design similar to the G3 assault rifle. It is adjustable (using a special tool) for windage and elevation, and for aperture size, with a very large aperture for speed in close combat and/or poor light conditions.

The MP5 has an 8.85-inch barrel and fires 650 rounds per minute. The overall length with rigid buttstock is 26.77 inches, 26 inches with retractable stock extended, and 19.29 inches with retractable stock closed. This compares with an overall length of 14.75 inches for the Walther MPK and 17.3 for the Uzi. The MP5 weighs 5.4 pounds unloaded with rigid butt, and 5.6 pounds with retractable stock. A box magazine holds 30 rounds and can be loaded by hand or with a special loading/unloading tool.

With a closed-bolt design, the MP5 has a decided advantage over open-bolt weapons for accuracy in semiautomatic fire. When the open-bolt moves forward after the trigger is pressed, it travels farther than the striker on a closed-bolt weapon, often jarring the shooter's aim somewhat at the moment of firing. For police work, the closed-bolt design is especially desirable if the weapon is to be employed with semiautomatic fire at a distance. Also, if close-range shooting is to be done in crowded areas, the submachine gun will probably be used on semiautomatic. In any case, the MP5 has been adopted as a standard weapon by the police forces of the Federal Republic of Germany and by the German Federal Border Police.

FIGURE 23
HECKLER & KOCH MP5A1 9mm SMG WITH STOCK RETRACTED



On semiautomatic the MP5 is accurate, with no jerk at the moment of firing. The 3-shot burst lever operates well in that when the trigger is held firmly to the rear only three rounds are discharged. When the lever is placed on full automatic (30), it is relatively easy to finger off two and three-shot bursts.

No malfunctions occurred during test firing using Finnish Lapua ammunition with semiautomatic, short burst, and 3-shot bursts fired continuously from six different magazines. The extraction process is hard on brass cases, but they can still be reloaded.

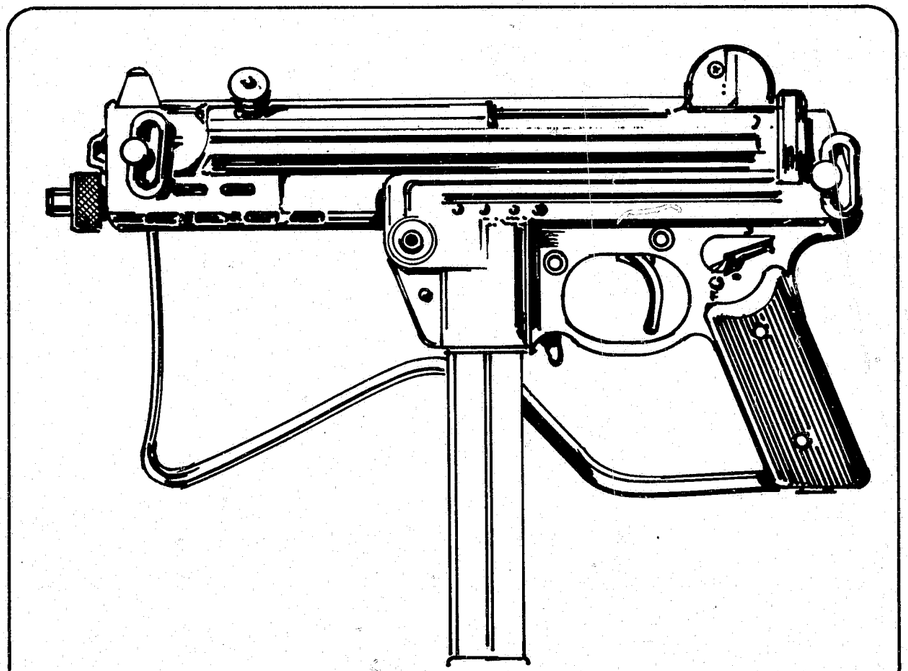
Very little recoil and muzzle rise were experienced. The retractable stock fitted well into the shoulder and aided controllability.

Walther MPK. The Carl Walther Waffenfabrik firm in Ulm/Donau, West Germany, introduced a new submachine gun in 1963. This weapon comes in two models: the MPL with an 18.1-inch barrel, and the MPK[8] with a 10.25-inch barrel. There is no apparent functional advantage to the longer barrel, and the MPK can be more readily concealed.

The military version of the MPK, illustrated in figure 24, is full automatic only, and not easily adaptable to police work. Those imported into this country are equipped with a semiautomatic capability activated by another position on the safety lever. In this model, the positions are marked D for full automatic, E for semiautomatic, and S for safe. The selector lever is well placed, just

[8]MP stands for *Maschinenpistole* or "Machine Pistol," the German word for submachine gun. K stands for *Kurz* which means "short."

FIGURE 24
WALTHER MPK



above the grip. This lever can be activated from either side of the gun to the benefit of left-handed shooters.

The magazine well is located immediately in front of the trigger guard, and is slightly funnel-shaped for ease of loading, especially in the dark. The magazine is of the Carl Gustav design and holds 32 rounds of 9 mm ammunition.

A metal skeleton stock can be folded to either side of the gun, and is well designed, bringing the eyes into line with the sights and effectively reducing recoil. The length of the MPK with the stock closed is 14.75 inches, compared to the Uzi's 17.3 inches. The 6.2-pound MPK is lighter than the 7.7-pound Uzi. The MPK is slightly bulkier because of the projection of the magazine in front of the trigger and the width of its stock, whereas the Uzi's stock folds under the receiver. However, when the magazine is removed, the MPK can be concealed under the jacket as easily as the Uzi.

The bolt retracting handle is not integral with the bolt and remains forward during firing. The handle, which has a large and comfortable shape, is located on the left upper side of the weapon.

The MPK fires from the open-bolt position, with most of the weight of the bolt above and forward of the bolt face. The bolt has longitudinal cuts in its sides which allow harmless accumulation of dirt.

An upper notch set for 75 meters and an aperture set for 125 meters provide the MPK with a dual sighting system. Both front and rear sights are protected.

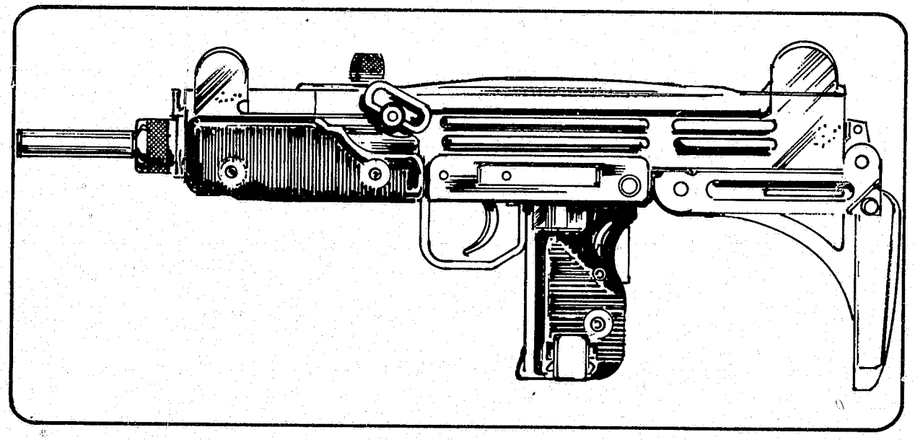
At 50 feet, using an aperture sight, it is possible to hit 6-inch by 6-inch targets easily with single shots or two-round bursts from the standing position. Since the retracting handle does not move and the barrel jacket does not heat up, it is possible to grip the weapon comfortably around the forearm and barrel. This makes the weapon comfortable to hold in both the shoulder or assault fire positions. The cyclic rate is 550 rounds per minute with 9 mm parabellum ammunition. A sling is mounted on the left side of the MPK for carrying around the neck.

The MPK costs approximately $125 and takes about three months for delivery, since federal law prohibits keeping any number of such guns in inventory.

I.M.I. Uzi. The Uzi submachine gun is named for Major Uziel Gal of the Israeli Armed Forces who designed the weapon in 1950. Its design was based on certain Czech weapons including the ZK476. Czech small arms designs are internationally famous, and Czech weapons were the staple of Israel's 1948 war. Major Gal improved on the Czech design, and his weapon is now manufactured by "Ta'as" (Israeli Military Industries) and by Fabrique Nationale in Belgium.

Figure 25 illustrates the Uzi, which is the most widely marketed submachine gun in the free world. Recently the gun was used by the Sudanese rebels fighting the Arab regime in Khartoum. It is an official weapon of the Netherlands and West Germany. In Germany, it is known as the MP2.

FIGURE 25
ISRAEL UZI SUBMACHINE GUN PARATROOP MODEL WITH FOLDING STOCK



The Uzi has a grip safety and a thumb safety. The thumb safety is located on the left side of the weapon and acts also as a selector lever. The selector has three positions: forward for full automatic, middle for semiautomatic, and rearward for safe. These positions are marked D, E, S, respectively, in German, and A, R, S, in English-speaking export countries.

Both the MP2 and later model I.D.F. (Israeli Defense Force) Uzi submachine guns have an extra safety in the form of serrations on the underside of the weapon cover beneath the cocking handle. These serrations prevent the bolt from going forward if the cocking motion is interrupted. In other words, if the firer's finger slips off the cocking handle, the bolt will not slide forward and accidentally fire a round.

Its telescoping bolt forms a sleeve over the 10.2-inch barrel, making the Uzi quite compact. In addition, the weapon feeds through the pistol grip, which reduces the Uzi's overall length. The paratroop model has a sturdy metal stock which folds under the receiver. The metal stock version is the only one that should be considered by U.S. police since when folded, it increases the portability of the weapon, and while extended, it allows the Uzi to be used as a rifle. The standard wooden stock, long or short version, of the Israeli Army ("Tsahal") Uzi can be detached with a single button and many soldiers remove the stock for portability, an extremely dangerous practice since it drastically limits the potential accuracy of the weapon.

The Uzi fires from the open-bolt position; when closed, the bolt serves as an effective dust cover. Longitudinal cuts in the receiver around the bolt serve to collect dirt and further increase the weapon's reliability. This weapon can be field-stripped for cleaning in a matter of seconds. However, stripping the weapon as well as adjusting the front sight should be a matter for the police armorer. The individual officer should know how to fire the weapon effectively and how to protect it from the elements, but maintenance responsibility should be centralized.

The Uzi has an adjustable front sight and an "L" type aperture rear sight with adjustments for 100 and 200 meters. Both front and rear sights are protected by wings.

A bolt retracting handle, which is located on the top of the receiver, does not move during firing. In later production, the handle was increased in size with a slit in the middle for sight visibility. The larger bolt handle is easier to grasp. A sling is mounted on the left side for carrying the weapon over the right shoulder. The Uzi fires from a 25, 32, or 40-round magazine at 650 rounds per minute.

The weapon weighs 7.7 pounds unloaded and can be easily controlled in full automatic fire. Short two and three-round bursts are not difficult to obtain.

The Uzi costs under $125 in the United States, and as with the Walther MPK, the waiting period is about three months.

GLOSSARY

Aperture or peep sight: A rear (receiver) sight on a shoulder weapon consisting of a round hole cut in a piece of metal. The shooter looks through the rear sight and centers the front sight in the middle of the aperture.

Assault rifle: A light infantry rifle capable of semiautomatic and full automatic fire using a special intermediate cartridge between pistol and high-power rifle ammunition. Examples: German MP44 firing 7.9 mm *Kurz* cartridge, or Soviet AK47 firing 7.62 x 39 mm cartridge.

Automatic carbine: U.S. M2 military carbine with selective semiautomatic and full automatic fire.

Automatic or full automatic or machine weapon: A weapon that by recoil or gas pressure loads and fires each successive round from the magazine with a single continuous pressure on the trigger.

Automatic rifle: A shoulder weapon, with a self-contained magazine, which fires high-power rifle ammunition with full automatic burst capability. Often used to describe an infantry squad support weapon such as the Browning Automatic Rifle (B.A.R.) or the M14A2, though it can also refer to light rifles with full automatic selector switch such as the F.A.L. or the M16A1.

Blowback operated weapon: An unlocked breech weapon in which gas pressure in the chamber against the bolt face opens the action (using the fired case as a piston).

Caliber (cal.): Measurement of bullet width in fractions of an inch.

Cyclic rate (of fire): Optimum number of rounds per minute fired full automatic given infinite magazine capacity and zero parts wear. Not a measure of how many rounds can actually be fired in a minute but rather how fast rounds are cycled through the action during full automatic fire.

Gas operated weapon: Locked breech weapon in which gas is bled off from the barrel to a piston which unlocks and opens the action.

Kick: Rearward thrust of firearm against a shooter. Kick varies with ballistic recoil, stock configuration, muzzle brake, and method of holding the weapon.

Machine gun: A weapon capable of firing rifle ammunition full automatic for extended periods from a belt or enclosed magazine. A machine gun may be permanently attached to a mount or fixed on a tripod or carried in the assault or used as a support weapon with bipod. It usually is heavier than an automatic rifle and is capable of firing longer bursts accurately due to less recoil.

M: Model.

Machine carbine: British term for submachine gun current in World War II.

mm: millimeter.

CONTINUED

1 OF 3

MP: Maschinenpistole in German, machine pistol in English, an interchangeable term with submachine gun.

Open or notch sight: A weapon rear sight consisting of a notch or groove cut into a piece of metal. The shooter aligns the front sight within the notch so that the top of the front sight does not extend above the notch and an equal amount of light appears on either side of the front sight between it and the sides of the notch.

Post or blade sight: Front sight on a weapon that appears like a straight post when viewed from the rear sight.

Retarded or delayed blowback operated weapon: An unlocked breech weapon in which a mechanical system retards the opening of the bolt, caused by the gas pressure of the fired round.

r.p.m.: rounds per minute.

Selector switch: The switch that determines by changes in sear position (or other means) whether a weapon fires full automatic or semiautomatic.

Semiautomatic or autoloading weapon: A weapon that by recoil or gas pressure loads a new round into the chamber and cocks the hammer or firing pin after each preceding round is fired. The trigger of the weapon must be pressed for each succeeding shot.

Subcarbine: A submachine gun converted to fire semiautomatic only, or a short semiautomatic carbine firing pistol ammunition.

SMG: Submachine gun.

Submachine gun: A portable machine gun which fires pistol ammunition.

9 mm: Approximate width of a specific pistol bullet. The case length of various types of 9 mm cartridges may vary (e.g. 9 mm *Kurz* or .380 a.c.p., 9 mm Steyr, 9 mm luger or parabellum), and these cartridges are not to be considered interchangeable.

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CS Characteristics (Brochure)
CS Decontamination (Brochure)

CHEMICAL AGENTS REPRINT SERIES

Toxicology of CN, CS and DM, Directorate of Medical Research, U.S. Army
Nonlethal Chemical Agents, Joseph F. Coates
Considerations in the Use of Irritants in Law Enforcement, Richard E. Reinnagel

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PWC staff and consultants are currently engaged in research in the following areas, and this work will be documented in future Report Series publications.

- *Police Body Armor*
- *Bomb Transport Vehicles*
- *Batons*
- *Aerosol Irritant Projectors*
- *Barricade Projectiles*
- *Urban Assault Tactics*

POLICE WEAPONS CENTER

WATER CANNON

LEONARD C. MILLER

REPORT SERIES 4-70

Management and Research Division ☐ International Association of Chiefs of Police
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WATER CANNON

CONTENTS

WATER CANNON

Although water cannon are not in use in the United States, several police departments in Germany and South America have employed such devices as a means of crowd control. The successful employment of mobile water cannon vehicles, especially in Germany, has resulted in frequent suggestions that they be used by police in the United States, generally as a substitute for chemical agents.

Basically, the concept of the use of water as a relatively innocuous method of crowd control is one that commends itself to police, since it provides a nonlethal means of control which can be employed against rioting mobs with greater selectivity and none of the decontamination problems associated with the use of chemical agents. While standard military and civil riot control literature in this country has traditionally referred to the use of water as an appropriate level of force, its actual use has been rather limited. However, the reluctance to use water has probably been due more to an absence of equipment and tactical doctrine than to any categorical rejection of the concept. Also, as a matter of municipal organization, water dispersing equipment has been in the hands of fire departments which have been extremely reluctant to risk their public image by involving themselves in unpopular enforcement activity.

Regarding the use of water, the FBI manual, *Prevention and Control of Mobs and Riots,* says:

- C. Fire Hoses
  Water from firehoses may be effective in moving small groups, in moving groups on a narrow front, or in defending a defile or roadblock. Water has been used in the recent past and has a psychological, as well as a physical effect. Water may be employed in two ways; as a flat trajectory weapon utilizing pressure, or as a high trajectory weapon akin to heavy rainfall. The latter method is especially effective during cold weather. If water is used in such ways, a harmless dye can be mixed into the stream for possible later identification of the rioters. Employed as a flat trajectory weapon, utilizing the pressure to physically move individuals, serious injury or death can result. The decision to employ water, in one or both methods, should be arrived at during the planning phase and should be based on the discretion of police and community officials.[1]

An earlier manual, FM 19-15, *Civil Disturbances and Disasters,* was recently updated to read, regarding water:

- (c) **Employment of water.** Water from a firehose may be effective in moving small groups on a narrow front such as a street or in defending a barricade or roadblock. Personnel applying the water should be protected by riflemen and in some instances by shields. In the use of water, the factors discussed in (i) and (v) below should be considered.

[1] Federal Bureau of Investigation, *Prevention and Control of Mobs and Riots* (Washington, D.C., U.S. Government Printing Office, 1967), p. 90.

(i) Water may be employed as a flat trajectory weapon utilizing pressure, or as a high trajectory weapon employing water as rainfall. The latter is highly effective during cold weather.

(ii) Harmless dye may be placed in the water for future identification of participants by staining their clothing or bodies.

(iii) The use of a large water tank (750-1000 gallons) and a powerful water pump mounted on a truck with a high pressure hose and nozzle capable of searching and traversing will enable troops to employ water as they advance. By having at least two such water trucks, one can be held in reserve for use when required.

(iv) In using water, as with other measures of force, certain restraints must be applied. Using water on innocent bystanders, such as women and children, should be avoided; avenues of escape must be provided; and the more severe use, flat trajectory application, should be used only when necessary.

(v) Since fire departments normally are associated with lifesaving practices rather than maintenance of law and order, consideration should be given to maintaining this image through the use of other than fire department equipment when using water for riot control and crowd dispersal.[2]

Where there is a readily available source of water supply, such as a modern urban hydrant system, fire trucks and pumpers can be utilized to deliver water against rioters, but this system has its limitations because of the difficulty of protecting the hoses and engines from the mob as well as the vulnerability of the hydrant system, which could be turned off from a remote location by rioters or sympathizers.

To avoid hydrant vulnerability and achieve mobility, the water cannon vehicle, a self-contained unit which permits police to confront mobs with high pressure water, was developed. Such vehicles normally carry a supply of water either as an integral part of the water cannon vehicle or in a towed trailer. Provision is also made for use of other water supply sources, such as rivers or lakes, and even, in the case of the Leipzig (East Germany) police, the municipal sewage system.

Several materials, such as tear producing agents, slippery foam, stenches and dyes, can be added to the water to discourage mobs. Experiments have even been conducted to devise a method for transmitting electrical shocks to rioters through streams of water.

Unfortunately, it has been difficult to escape the fact that all water cannon are extremely vulnerable vehicles. Merely by waiting until the device exhausts its water supply, rioters can attack and destroy an expensive piece of virtually defenseless equipment with Molotov cocktails or other weapons. In addition to their high cost and vulnerability, water cannon have sometimes experienced serious maintenance problems with their pumping equipment. As a result of these shortcomings, the

[2]Department of the Army, *Civil Disturbances and Disasters,* FM 19-15, Change 2, (Washington, D.C.: U.S. Government Printing Office, March 1968) para. 17-4.

water cannon has been found to be unsatisfactory by the Venezuelan, Equadorian and Peruvian police and its use as a riot control device has not spread to the United States.

The use of high pressure water as an antiriot mechanism is currently most common in Germany, where the technique has been backed up by the development of water cannon of great power and precision. Equivalent American equipment does not exist, although one German manufacturer has recently established an American distribution outlet: JAFCO Systems, Inc., 5 West Street, Hyde Park, Boston, Massachusetts 02136.

The following descriptions of two German water cannon have been provided by the manufacturers. Their claims however have not been verified by the IACP. The devices described are the ISAR water cannon produced by Keller & Knappich GmbH, 89 Augsburg 3, Germany, and the Daimler-Benz water cannon, with a special upper body manufactured by Meyer-Hagen, 58 Hagen (Westfalen) Postfach 1143, Germany. Three other German firms can manufacture the upper body to fit the Daimler-Benz chassis, these are Carl Metz, 75 Karlsruhe (Baden) Germany, Klockner-Humboldt-Deutz, 79 Ulm, Postfach 543, Germany and Rosenbauer KG, POB 4021, Linz, Austria.

THE KELLER AND KNAPPICH WATER CANNON

The Keller and Knappich water cannon, illustrated in Figures 1 and 2, is described as follows:

The Body. The crew cab serves as a control station and provides space for the driver and a crew of five to six men. There are three individual seats in front and a full-length back seat; batteries, a self-contained heater and extra space for tools and supplies are fitted beneath. The heater also provides ventilation by means of two vents in the roof. The exterior of the cab consists of sheet steel, 3 mm in thickness, and the cab interior is coated with plastic. There are large windows on all sides, with panes of glass reportedly capable of deflecting .22 caliber bullets. The windows are protected against thrown objects by woven wire and mesh screens. The windshield is provided with a special washing device carrying solvents for the removal of any paint thrown by rioters. There are three doors on the right side of the vehicle and one for the driver on the left. All doors can be bolted from the inside; the third one on the right can also be locked from the outside.

Two ejection nozzles with waterproof covers are mounted on the roof. Eaves along the edges of the roof prevent the obscuring of vision by any overflow of water that would otherwise pour over the windows.

Water Tank. The water tank, constructed of sheet steel, has a volume of 2,297 gallons. Internal braces inside the tank also serve as baffle plates.

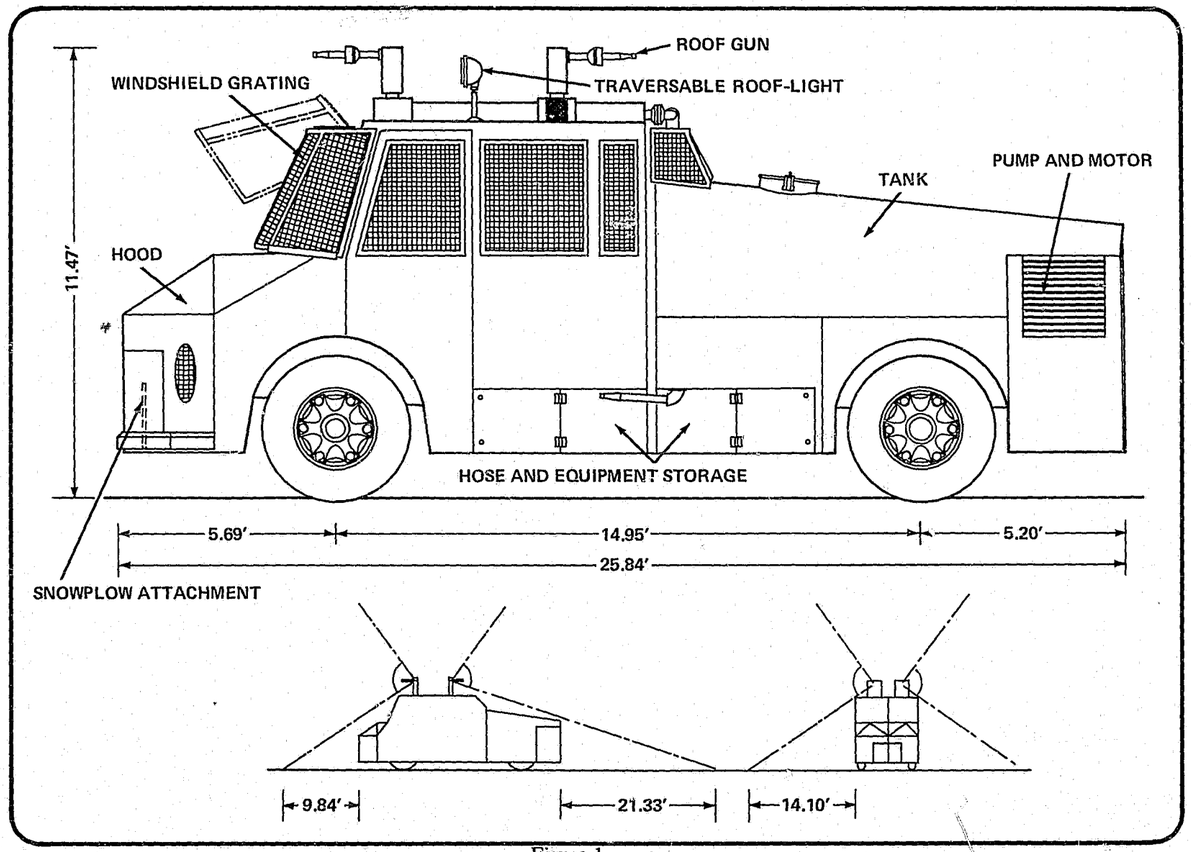

Figure 1
THE KELLER AND KNAPPICH "ISAR"
WATER CANNON
(Side View)

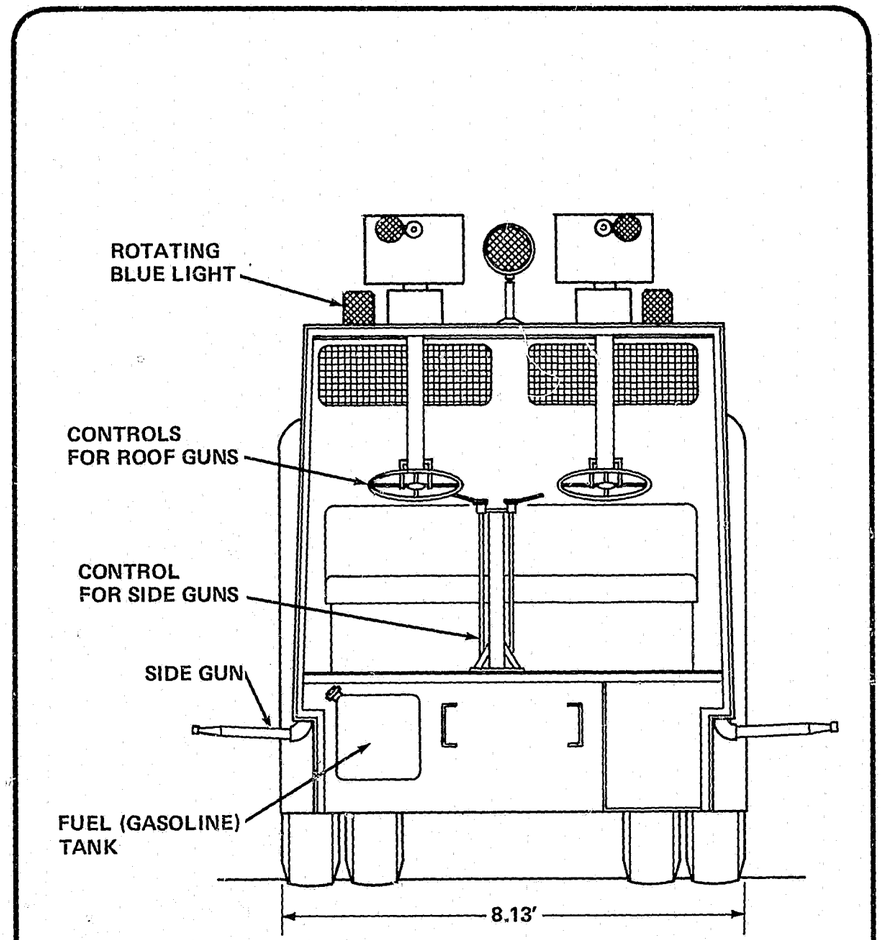

Figure 2
THE KELLER AND KNAPPICH "ISAR"
WATER CANNON
(Rear View)

The filling connection is located on the right side of the tank. A manhole on the top of the tank permits entry of inspection personnel. The water level can be observed through an inspection glass from inside the cab. Also, an audible and an optical device indicate when the water level in the tank falls to 391.4 gallons, approximately 1/5 full. The water pressure is indicated by a pressure gage inside the cab.

The interior of the tank is water resistant, and the connections are galvanized. In the winter, an electric heater prevents the water from freezing.

Water Pump and Motor Assembly. The water pump and motor assembly is installed at the vehicle's rear and is provided with a 3-mm-thick sheet steel cover. Both the water pump and its driving engine are located on a frame which is fitted crosswise to the length of the vehicle. This arrangement permits ready access for inspection, installation and removal of the complete assembly. The motor is controlled from the crew cab, and an additional push-button starter is located within the pump motor compartment. A centrifugal pump, electrically driven, is used for filling from open water sources. The electric motor for this pump is driven by the 12 V main vehicle engine.

Protective Hood. The protective hood consists of 3-mm sheet steel which protects the driving (main) engine and the vehicle's front end. Its wedge shape serves to shed any impeding debris. The upper portion of the hood may be removed for servicing the main engine. The V point of the wedge, to the back of which a snowplow attaching plate can be fitted, is also removable. These detachable members are held in place by rapid action couplings which can be opened only with a special key to protect them from tampering.

Piping Connections. For pumping water from open sources such as rivers and lakes, there is a suction pump located in the pump motor assembly controlled from the crew cab. The suction pipe is provided with a back pressure valve and an A-coupling with a screen to prevent solid material from entering the system. A vertical action pump is also connected to the suction pipe and the vacuum reading indicated on a manometer in the crew cab.

The pressure pump is connected to the four jet nozzles. One branch is connected to a fire extinguisher. Another connection, with two nozzles, is provided for flushing the windshield and extinguishing burning liquids.

All conduits are protected by flexible connections which prevent damage should the vehicle jackknife. The water pressure is indicated by a pressure gauge located in the crew cab. When the vehicle is used to transport drinking water, a special galvanized outlet equipped with a stopcock is provided.

Water Gun Battery. The water gun battery consists of two roof-mounted and two lateral nozzles controlled by means of a foot-operated three-way valve. All water jet guns are mounted in solid light metal molds equipped with roller bearings and are fitted with interchangable nozzles.

KELLER AND KNAPPICH WATER CANNON
Technical Data

Short-hooded with all-wheel drive MAN 13 215 HA Power 215 hp

Dimensions:

Wheel Base	185 in.
Length	318 in.
Width	100 in.
Height	141.2 in.

Weight:

Front Axle	13,227.6 lbs.
Rear Axle	28,659.8 lbs.
Total	41,887.4 lbs.

Tank Volume: 2,297.75 gal.

Auxiliary Engine: MAN D 0834 M

Constant Power — 72 hp at n* = 2030 r.p.m.
Fuel Consumption — 167 g/hp-hr. at n = 2030 r.p.m.
Short Period Power — 85 hp at n = 2300 r.p.m.
Fuel Consumption — 180 g/hp-hr. at n = 2300 r.p.m.
Max. Constant Power — 75 hp at n = 2200 r.p.m.

High Pressure Pump: KSB — WKL 80/5

Output 422.8 gal./min. at n = 2030 r.p.m.

Water Jet Guns

Roof Water Jet Guns — Aiming

Horizontal	360°
Vertical	35° downward 55° upward

Nozzle diameter: 12, 14, and 16 mm interchangable

Lateral Water Jet Guns

Aiming	Horizontal approximately 170°
Nozzle diameter	12 mm

n* = Normal

Figure 3

The roof water jet guns are movable both in the horizontal and vertical plane, and are controlled by hand wheels located inside the cab.

The lateral water jet guns are movable in the horizontal plane only and are controlled by hand levers located inside the cab and connected to the jet pipes by flexible belts.

A set of synchronous controls makes possible the simultaneous control of all four water jet guns.

THE DAIMLER-BENZ WATER CANNON

The Frankfurt (Germany) Police Department has two water cannon manufactured by Daimler-Benz GmbH, with a special upper body fabricated by Meyer-Hagen Company (Figures 4, 9). They are equipped with a 140 horsepower engine having a stroke volume of 344 cubic inches. The total weight is 11.55 tons.

Body. The crew compartment accommodates a driver and four crew members. All windows and headlights are provided with guard grilles against stones, and the window panes are of bulletproof glass. The upper body is constructed of sheet steel, but upon special request the superstructure manufacturer delivers the vehicle with light armoring. The exterior of the vehicle is smooth and devoid of handles which might tempt demonstrators to climb on the vehicle.

Water Tank. The tank holds 1100 gallons of water. Two main water jet guns connected to the water tank are installed in an elevated position on the roof. These water jet guns can be independently aimed, both in azimuth and elevation. Additional spray pipes are installed on all four sides beneath the vehicle to prevent attack on the water cannon by rioters.

Water Pumps. The water pumps are driven by an air-cooled, four-cylinder, 38 horsepower Volkswagen engine, which operates independently from the main engine. Consequently, the water pressure remains stable even when the main engine is not operating. If water is ejected continuously at 147 p.s.i. with a nozzle diameter of 0.4 inches, the water reserves last 25 minutes. If water is ejected intermittently, it lasts approximately 40 to 45 minutes. At 147 p.s.i. and a nozzle diameter of 0.48 inches, the jet has a range of approximately 118 yards.

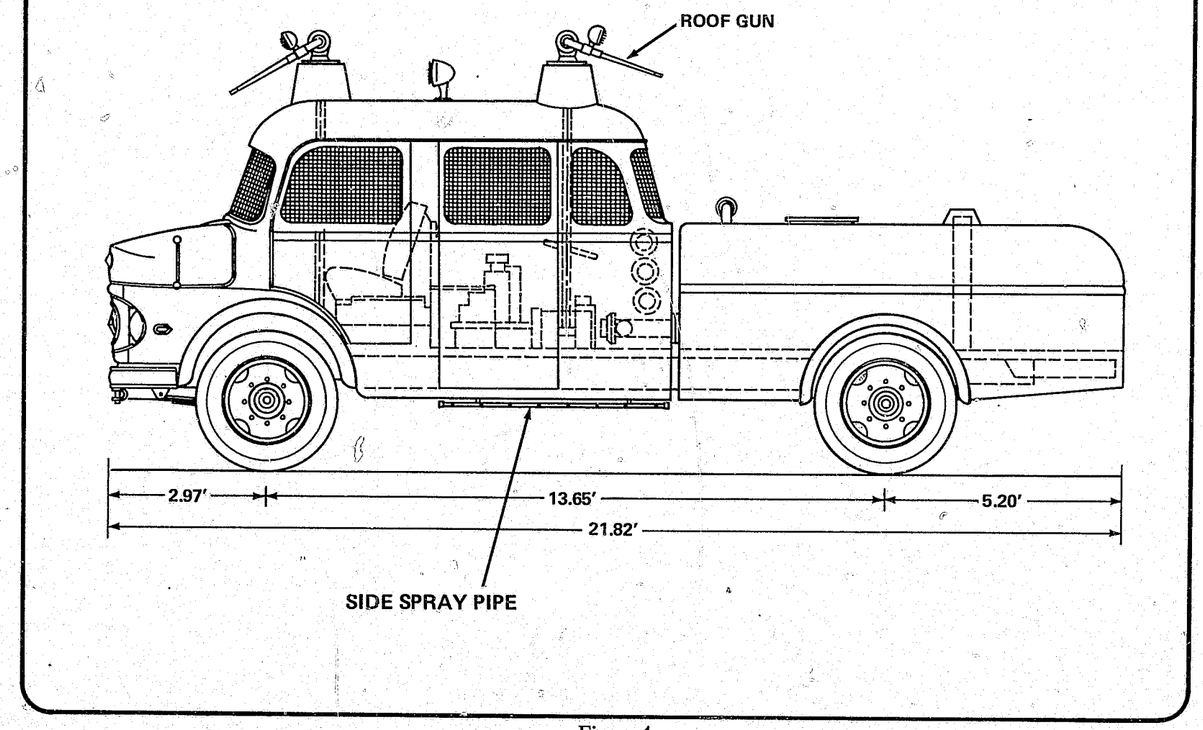

Figure 4
THE DAIMLER-BENZ WATER CANNON
(Side View)

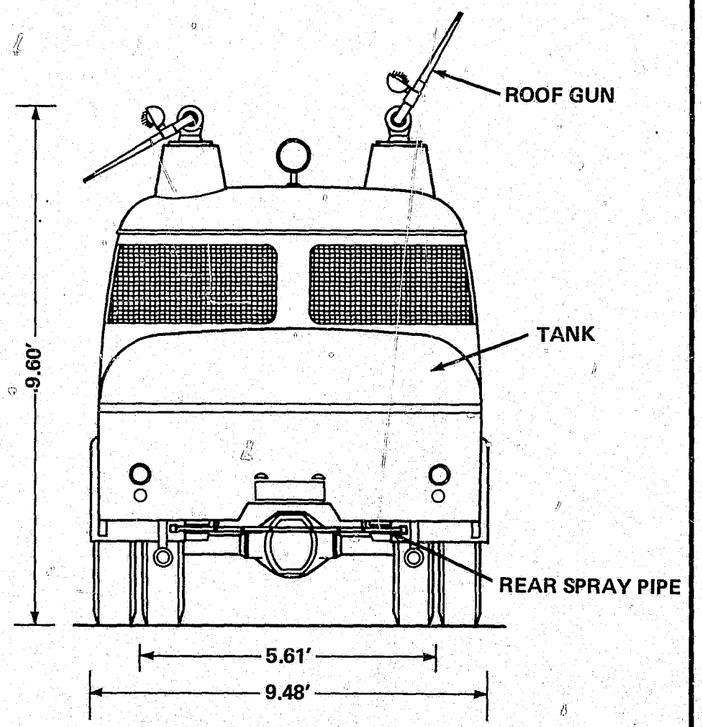

Figure 5
THE DAIMLER-BENZ WATER CANNON
(Rear View)

Tactics. The Frankfort Police does not consider water cannon employed during demonstrations as weapons, but rather as means of physical force. They are used only when simple physical force does not seem to be effective and the use of firearms should be avoided. They are used to clear streets and open areas as well as to protect buildings, facilities, and equipment. This equipment can also be used during natural catastrophes, and is, therefore, kept constantly filled with drinking water.

The Frankfort Police report the following as situations in which a water cannon can be utilized effectively in controlling a demonstration:

- If, for example, spectators to the rear of a mob are preventing the demonstrators from retreating, then the spectators are sprinkled first, thereby dispersing them and allowing an avenue of retreat to the mob. The water falling on the spectators, of course, falls in the form of a spray with no force and little consequent danger to the onlookers.

- Demonstrators can be prevented from advancing, or at least a space can be maintained between the police and a mob by creating a water barrier between the police and the demonstrators. This is done by directing the jet of water immediately to the front of the demonstrators. A water jet employed in this manner will also knock down small barricades.

- A full jet can be used against obstinate demonstrators to prevent them from pressing forward or to force them to retreat. An effective method of employment is to utilize the full force of the jet in short, intermittent bursts.

The effect of direct fire is increased and the danger of injury reduced when the water is mixed with a foaming agent such as Tutogen N. This agent consists of chemicals which have no permanent deleterious effect, and stained clothing can be rinsed out in water. The foam stings the eyes and makes the clothing clammy, heavy, and slow drying if a wetting agent has also been added to the water. When a foaming agent is added to the water, reserves last much longer. According to information from the Meyer-Hagen Company, 990 gallons of water make 8,580 gallons of foam.

In Frankfurt, the water cannon is never used with foam agents since the tanks are kept filled with drinking water at all times in the event of a public emergency.

DAIMLER-BENZ
Technical Data

Pump Capacity:

The maximum pressure is 235 p.s.i.

The nozzle is 0.4, 0.48, or 0.56 inch.

29 p.s.i. approximately 66 gal./min.
73 p.s.i. approximately 132 gal./min.
118 p.s.i. approximately 176 gal./min.
147 p.s.i. approximately 220 gal./min.
176 p.s.i. approximately 286 gal./min.
221 p.s.i. approximately 352 gal./min.

Water Consumption at 147 p.s.i.

Nozzle diameter — 0.40 in. = 44 gal./min.
Nozzle diameter — 0.48 in. = 66 gal./min.
Nozzle diameter — 0.56 in. = 88 gal./min.

Figure 6

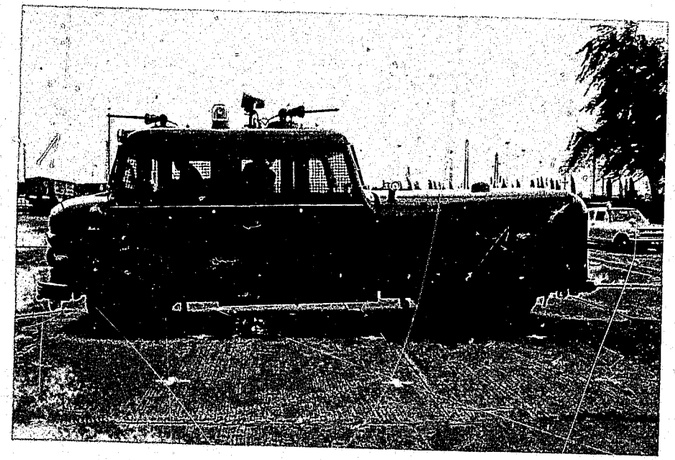

Figure 7
DAIMLER-BENZ WATER CANNON
(Side View)

Figure 8
DAIMLER-BENZ WATER CANNON
(Oblique View)

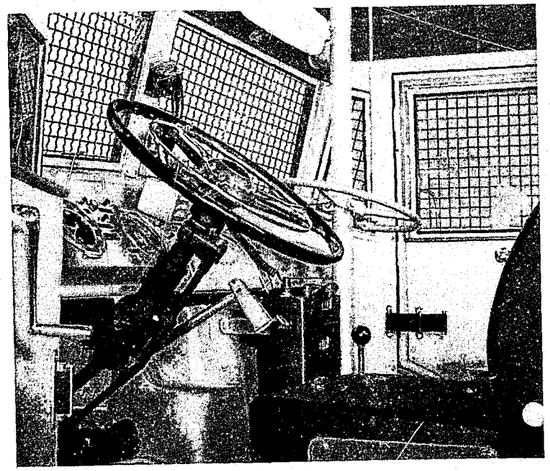

Figure 9
DAIMLER-BENZ WATER CANNON
(Interior and Operational Views)

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The following publications are available upon request at no cost unless otherwise indicated.

REPORT SERIES

1-70 *Selected Basic Reference Bibliography*
2-70 *Protective Masks*
3-70 *Submachine Guns in Police Work*
4-70 *Water Cannon*

REPRINT SERIES

1-70 *Procedures for the Sale of Military Weapons and Protective Equipment to Public Safety Agencies*

CHEMICAL AGENTS SERIES

Police Chemical Munitions Handbook
Police Chemical Agents Manual ($1.50)
CS Characteristics (Brochure)
CS Decontamination (Brochure)

CHEMICAL AGENTS REPRINT SERIES

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- *Urban Assault Tactics*

POLICE WEAPONS CENTER

POLICE BODY ARMOR

LEONARD C. MILLER

REPORT SERIES 5-70

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Research Division ▫ International Association of Chiefs of Police
11 FIRSTFIELD ROAD ◇ GAITHERSBURG, MARYLAND 20760 • AREA CODE 301—TEL. 948-0922

CONTENTS

During January, 1971, 23 commercially available body armor units reporting the products of 12 manufacturers were ballistically tested at the Naval Research Laboratory, Washington, D.C.; this was done under the direction of the Law Enforcement Standards Laboratory which the National Bureau of Standards is operating under a grant from the National Institute of Law Enforcement and Criminal Justice, Law Enforcement Assistance Administration, United States Department of Justice. The results of these tests are reported in the section starting on page 22.

POLICE BODY ARMOR

INTRODUCTION

For over 3,000 years, military forces used armor as a protection against missiles and hand-held weapons, but with the advent of the longbow and the introduction of gun powder, armor was no longer effective and ceased to be used, except for ceremonial purposes. Not until World War I was there a rebirth of interest in personal armor to defend the individual against shell fragments and projectiles. During World War II, body armor was further developed to protect personnel, especially air crews, against bomb and shell fragments. However, none of the types of military armor developed offered any substantial protection against hand weapons.

Until recently, police forces have had only a sporadic need for body armor, usually in connection with attempts to dislodge barricaded criminals. The recent increase in violent civil disorders and assaults on police officers has generated a new interest in protective armor, including a critical review of the characteristics of on-hand armor as well as the merits of newer units being vigorously marketed to the law enforcement community.

There are four basic situations in which police might utilize body armor: (1) the barricaded criminal or psychotic, (2) riot control situations, (3) protection of certain prominent and highly vulnerable individuals, and (4) bomb squad operations. The latter application is not discussed in this report since it involves a highly specialized type of operation sufficiently important to warrant separate and more detailed consideration.

While operations involving barricaded criminals, riot control, and VIP protection each present different protective requirements, there are basically three questions which must be considered in the selection of body armor for any police operation:

- What protection should the armor give?
- What loss of mobility and efficiency will be caused by the wearing of armor?
- What is the cost of armor in relation to the protection provided?

Protection

How much protection should the armor give? Obviously, the size of the weapon fired against the armored man determines the thickness and weight of the armor. Ideally, armor should be able to stop a 20 mm cannon shell and weigh no more than a few ounces. However, the state of the art precludes development of such armor, and some compromise must be reached that reflects the capability of the armorer.

Armor is essentially a means of providing protection for police personnel against a given threat. Figure 1 summarizes the threats presented by a selected group of firearms. The damage inflicted by a particular bullet when it strikes an individual or object depends on factors such as bullet weight, velocity, and design configuration. All other things being equal, the muzzle impact energy of a bullet, which is a function of its weight and velocity, is one of the most important factors to be considered in the selection of protective armor. As a general rule, the level of protective armor necessary to stop the bullet must increase as impact energy increases.

For the purpose of comparison, the data in figure 1 are arranged in order of increasing muzzle energy. Bullets fired from handguns are generally much lower in energy than are bullets of comparable size and weight fired from rifles. It follows then that the level of armor to defeat handgun bullets is less than that required to defeat rifle bullets.

Type of Bullet	Muzzle Typical Velocity, feet per second	Bullet Weight, grains	Muzzle Impact Energy, foot-pounds
.32 S & W Long	705	98	115
.22 Long Rifle	1,335	40	158
.38 Special	855	158	255
9 mm Parabellum	1,140	115	332
.45 ACP	860	230	370
.38 Super Auto	1,280	130	475
.357 Magnum	1,550	158	845
.30 Carbine	1,980	110	955
.44 Rem. Magnum	1,470	240	1,150
.223 (5.56 mm) Rem.	3,300	55	1,330
.243 Winchester	3,070	100	2.090
.300 Savage	2,370	180	2,240
7 mm Mauser	2,490	175	2,410
8 mm Mauser	2,570	170	2,490
12 Gauge (Rifled slug)	1,600	438	2,490
7.62 mm NATO	2,860	150	2,730
.30 Cal M2	2,970	150	2,930

Figure 1
CHARACTERISTICS OF TYPICAL SMALL ARMS AMMUNITION

In the selection of armor, the challenge is essentially one of matching various existing armor systems to the weapon caliber or calibers which constitute the anticipated threat. An important point to remember, however, is that the matching of armor and threat has practical limits. The number of types of armor which can be stocked by police departments is sharply limited by cost considerations. To provide multiple armor units for each man to meet any eventuality is unrealistic. If the expected principal threat is a caliber .38 handgun, a lighter armor would be selected than if the threat were from caliber .30 fire. The armor designed to stop caliber .30 rifle bullets might also stop caliber .38 handgun slugs, but the equipment would be heavier and more cumbersome. Any advantage that might be gained by using the heavier-than-necessary armor protection would be offset by a reduction in mobility and comfort for the wearer, as well as a marked increase in fatigue.

The police departments of several large cities of the United States were surveyed as to the distribution, by type and caliber, of firearms seized as a result of confiscation following criminal action, suicide, or voluntary surrender. The distribution of this sample of guns processed by the police probably provides a general indication of the types of firearms available for use against police, and, consequently, is some reflection of the nature of the principle threat posed to police personnel.

The results of this survey, summarized in figure 2, demonstrate, among other points, that caliber .22 and caliber .38 handguns are by far the most common firearms, representing almost 55 percent of the total number of weapons reported, as illustrated in figure 3. The popularity of these two calibers can be explained by the low cost and easy availability of both the arms and the ammunition.

Police Department	RIFLES										SHOTGUNS										SMG		Total Shoulder	
	.22	%	30.30	%	30.06	%	Misc	%	Total	%	12 ga	%	16 ga	%	20 ga	%	.410	%	Total	%	Total	%	No	%
New York	NOT REPORTED								429	7.04	NOT REPORTED								284	4.66	8	0.13	721	11.64
Memphis	7	3.13	1	0.45	2	0.89	0	0	10	4.47	15	6.70	0	0	6	2.68	1	0.45	22	9.83	0	0	32	14.30
Seattle	60	8.45	42	5.92	12	1.69	19	1.27	133	26.08	40	5.63	6	0.85	5	0.70	36	5.07	87	17.06	0	0	220	43.14
Buffalo	0	0	0	0	9	3.36	0	0	9	3.36	31	11.57	8	2.99	7	2.61	5	1.87	51	19.03	0	0	60	22.39
Phoenix	48	7.74	10	1.61	12	1.94	37	5.96	107	17.26	43	6.94	11	1.77	10	1.61	12	1.94	76	12.26	1	0.16	184	29.68
Columbus	24	6.17	3	0.77	1	0.26	0	0	28	7.20	37	9.51	14	3.60	7	1.80	5	1.29	63	16.20	1	0.26	92	23.65
Dallas	91	5.14	12	0.68	2	0.11	32	1.88	137	7.74	130	7.35	22	1.24	37	2.09	36	2.04	225	12.72	0	0	362	20.46
Kansas City	34	6.16	4	0.72	2	0.36	6	1.09	46	8.19	29	5.25	8	1.45	10	1.81	8	1.45	55	9.79	0	0	101	17.98
Philadelphia	NOT REPORTED								561	13.23	NOT REPORTED								521	12.29	0	0	1082	25.52
St. Louis	118	8.13	0	0	0	0	46	3.17	164	11.30	119	8.20	25	1.72	11	0.76	39	2.69	194	13.37	0	0	358	24.67
Washington, D.C.	41	4.04	9	0.89	0	0	6	0.59	56	5.56	60	5.91	5	0.49	18	1.77	10	0.98	93	9.24	0	0	149	14.80
San Diego	0	0	2	0.6	7	2.2	14	4.3	23	7.21	18	5.6	6	1.9	6	1.9	5	1.6	35	10.98	0	0	58	18.19
Total	423		83		47		160		1,703		522		105		117		157		1,706		10		3,419	

Police Department	HAND GUNS																								Total Weapons
	.22	%	.25	%	.32	%	.38	%	.357	%	.380	%	.44	%	.45	%	9mm	%	Misc	%	Total	%		
New York	1,859	30	663	10.70	985	15.90	1,721	27.76	16	0.26	0	0	9	0.15	101	1.63	113	1.82	5	0.08	5,472	88.36			6,193
Memphis	85	37.95	13	5.81	25	11.16	54	24.11	2	0.89	2	0.89	2	0.89	5	2.23	4	1.79	0	0	192	85.70			224
Seattle	72	14.31	17	2.39	19	2.68	108	21.18	20	2.82	24	3.38	0	0	12	1.69	18	2.54	0	0	290	56.86			510
Buffalo	108	40.30	20	7.46	28	10.45	45	16.79	3	1.12	0	0	0	0	4	1.49	0	0	0	0	208	77.61			268
Phoenix	217	34.94	25	4.03	36	5.81	107	17.26	15	2.42	2	0.32	5	0.81	15	2.42	5	0.81	10	1.61	437	70.48			621
Columbus	131	33.68	35	8.99	52	13.37	59	15.17	6	1.54	0	0	1	0.26	5	1.29	8	2.06	0	0	297	76.35			389
Dallas	623	35.23	145	8.19	175	9.89	377	21.31	8	0.45	33	1.87	2	0.11	37	2.09	1	0.06	6	0.34	1,407	79.54			1,769
Kansas City	121	21.92	51	9.24	88	15.94	173	31.84	3	0.54	3	0.54	2	0.36	16	2.90	0	0	4	0.73	461	82.02			562
Philadelphia	NOT REPORTED														NOT REPORTED						3158	74.48			4,240
St. Louis	323	22.61	121	8.34	195	13.44	360	24.81	0	0	13	0.90	6	0.41	32	2.21	30	2.07	8	0.55	1,093	75.33			1,451
Washington, D.C.	306	30.19	94	9.25	170	16.74	224	22.05	8	0.79	3	0.30	1	0.10	27	2.67	22	2.17	3	0.30	858	85.20			1,007
San Diego	126	39.5	30	9.4	26	8.2	45	14.1	7	2.2	7	2.2	2	0.6	11	3.4	6	1.9	1	0.3	261	81.81			319
Total	3,976		1,214		1,799		3,273		88		87		30		265		207		37		14,134				17,553

Figure 2
CONFISCATED WEAPONS

Police Department	Caliber .22	Caliber .38	Total	Total Weapons Reported	Percentage
New York	1,859	1,721	3,580	6,193	57.80
Memphis	85	54	139	224	62.05
Seattle	72	108	180	510	35.29
Buffalo	108	45	153	268	57.08
Phoenix	217	107	324	620	52.25
Columbus	131	59	190	389	48.84
Dallas	623	377	1,000	1,769	56.52
Kansas City	121	173	294	562	52.31
St. Louis	325	360	688	1,451	47.41
Washington, D.C.	306	244	550	1,007	54.62
San Diego	126	45	171	319	53.60
Total	**3,976**	**3,293**	**7,269**	**13,312**	**54.60**

Figure 3
CALIBER .22 AND CALIBER .38 HANDGUNS AS PERCENTAGE OF TOTAL WEAPONS REPORTED

The proportion of shoulder weapons in the sample taken varied from 11.64 percent (New York) to 43.14 percent (Seattle) of all weapons, with no national pattern apparent. For example, Philadelphia, only 90 miles from New York, reported 25.52 percent shoulder weapons as contrasted with New York's 11.64 percent. Of the 1,703 rifles reported, the caliber .22 represented 60.17 percent of the total and was the most popular caliber, probably because of the low cost of the weapon as compared with other available rifles.

It would appear from this survey that, among handguns, the caliber .22 and the caliber .38 pose the most common threat. Among shoulder weapons, the caliber .22 is again the most common threat.

Generally speaking, armor is used when it is known or suspected that police will draw fire; and in most cases, the use of armor will provide the wearer with the degree of protection for which the armor is rated.

However, it should be noted that armor will cause mushrooming or, in the case of ceramic armor, disintegration of the impacting round. Should the round subsequently penetrate the armor, the resulting wound will be irregular in nature and the bullet will probably inflict greater injury than it would if no armor were worn. This is especially likely to occur if the armor is hit by a higher caliber round than it is designed to stop. In some cases, especially where glass reinforced plastic armor is worn, the introduction into the wound of bits of fiber glass, which is not visible under X-ray, can be a cause of serious infection.

Mobility and Efficiency

The weight of protective armor is roughly proportional to the degree of protection it gives, and varies from 3.69 pounds for an armored vest which is rated to protect against caliber .38 special ammunition, to over 30 pounds for a protective vest which is rated to defeat caliber .30 armor piercing rounds. Obviously, to conduct rapid maneuvers for extended periods carrying an added weight of 30 pounds will be more fatiguing than carrying 3.69 pounds.

While almost any use of body armor will result in some loss of mobility and reduced efficiency, the greatest fatigue results from the prolonged wearing of armor under hot, humid weather conditions. Tests conducted at Camp Lejeune, North Carolina, by the U.S. Navy found that the impermeability of body armor, rather than its weight, was the most important factor in causing heat exhaustion under hot, humid conditions, Even in cases which did not go to complete heat exhaustion, there was a marked reduction in the effectiveness in personnel wearing body armor because of insufficient evaporation of body perspiration.

R.F. Goldman of the U.S. Army Research Institute of Environmental Medicine, writes in an article for *Military Medicine* that:

> Man's resting heat production, about 70 kilocalories (Kcal) per hour, is increased five- or tenfold during exercise. He compensates for this additional heat production largely through the production and evaporation of sweat. Thus, during work, although his deep body temperature rises slightly, it is kept at physiologically safe levels by sweat evaporating and thus cooling both the skin and the blood supplied to it from the deep body centers. Unevaporated sweat is worse than useless, since it not only produces no cooling but results in increased loss of body water.[1]

It was found by the U.S. Navy that:

> In unacclimatized men, both rectal and skin temperatures rise faster and higher in men wearing body armor than in those not wearing it. Only 39 percent of men wearing body armor, as opposed to 77 percent of men not wearing body armor, were able to complete a 90-minute march under conditions of load and climate approximating those found in Southeast Asia.[2]

However, in other tests by the U.S. Navy, it was determined that fatigue resulting from the wearing of body armor did not adversely affect marksmanship.[3] In any event, it would appear that the detrimental effects of body armor mobility and efficiency are based on temperature, humidity, and the amount of motion required of the wearer, rather than on the weight of the armor alone.

The tests cited above showed that young, fit men withstand the effects of wearing body armor in hot, humid climates better than older men. This can pose a problem for some police departments, since the older man, with the greater possibility of his carrying excess fat and a greater probability of physical defects, is more likely to be in a leadership position. This points up to the necessity of providing frequent rest breaks, a readily available supply of water, and salt tablets for all police engaged in any prolonged armored action under hot, humid conditions, such as might occur in summer civil disorder operations.

Needless to say, police body armor should be designed in such a way that the firing of hand or shoulder weapons is not inhibited. While military armor units for combat troops are designed to

[1] R.F. Goldman, "Physiological Cost of Body Armor," *Military Medicine*, Vol. 134, No. 3, March 1969, p. 3.

[2] W.E. Yarger, L.H. Cronau, Jr., and R.F. Goldman, "Body Armor in a Hot Humid Environment," Part 1: Studies in Unacclimatized Men. *Naval Medical Field Research Laboratory Report*, Vol. 18, No. 16, September, 1968, p. iii.

[3] R.S. Leopoid and L.G. Derrick, "The Influence of Wearing Body Armor of Different Designs, Materials and Weights on the Marksmanship of the Marine," *Naval Medical Field Research Laboratory Report*, Vol. 12, March, 1962.

permit the use of firearms, a number of units designed for police use severely limit or preclude the firing of shoulder weapons. For law enforcement applications, the body armor unit should permit the accurate use of shotguns or rifles from at least each of the standard firing positions.

A consideration related to mobility and efficiency involves the speed with which an armor unit can be employed. In some cases officers may be required to get into body armor while inside or crouched behind vehicles and conceivably while under fire. When comparing body armor options, consideration should be given to the time required for trained and untrained personnel to get protective units into position.

Costs of Body Armor

Like the weight of body armor, the cost is also roughly proportional to the degree of protection provided. Heavier armor which protects against caliber .30 armor piercing rounds costs up to $500 per complete set, while a complete set of lighter armor which defeats caliber .38 special ammunition can be obtained for approximately $65. Police departments must consider the cost of armor against the real and intangible costs of losing a trained officer as well as against the loss of efficiency which may ensue from wearing excessively heavy armor.

From the cost/effectiveness standpoint, it would appear desirable for a police department to procure a minimal number of sets of heavy armor for use in extracting barricaded criminals or countersniper operations. For general riot duty, a lighter, less expensive type of armor should be obtained.

BODY ARMOR MATERIALS

There are five types of materials currently considered appropriate for use in the manufacture of body armor:

- Ballistic nylon or other cloth, felted or nonfelted.
- Glass reinforced plastic, either compressed (Doron) or in the form of woven rovings.
- Metals such as steel, titanium, and aluminum.
- Ceramics, such as boron carbide or aluminum oxide.
- Polycarbonate resin.

Ballistic Nylon

The original body armor developed during World War II was composed of eight layers of heavy nylon cloth, which partially protected the wearer against flak fragments from antiaircraft shells. In Korea, the U.S. Army provided infantrymen with the M1952 vest composed of twelve layers of ballistic nylon, which afforded protection against shell fragments and, hopefully, ricocheting small arms bullets. The U.S. Marine Corps later developed their M1955 jacket which combined thirteen layers of ballistic nylon with inserts of glass reinforced plastic.

In general, ballistic nylon alone, although useful as protection against fragments from shells and grenades, is less effective in protecting men against small arms fire.

Glass Reinforced Plastic

Glass reinforced plastic is usually called "Fiberglas," although the term is a registered trade name for one specific brand of glass reinforced plastic. Therefore, the use of the generic term, abbreviated

to GRP, is preferable. GRP exists in two forms which are useful in making body armor: woven rovings and compressed. In manufacturing woven rovings, sheets of woven glass fibers are hand laid upon a form using an adhesive resin between layers. A squeegee is used to compress the material and prevent the formation of air bubbles between the layers. The complete unit is then vacuum-bagged and baked in an autoclave at high heat until dry.

Doron is a GRP which is compressed under high heat and heavy pressure to form a denser material than that which can be produced by the woven roving method. When used in body armor, both GRP materials have a tendency to delaminate in the area around the point of bullet impact and may subsequently provide reduced protection in that area.

Metals

There are four metallic, lightweight armor materials and all except dual hardness steel are homogeneous materials:

- Aluminum Alloy
- Titanium Alloy
- Homogeneous Steel
- Dual Hardness Steel

Unlike ceramic armor, the metallic armors are considered structural materials. As such, they are most suitable for vehicle application where extra weight can be handled without undue penalty. In the manufacture of armor, aluminum and titanium alloys are readily formed and welded by conventional methods, while steel armors, such as homogeneous steel armor and dual hardness armor, are more difficult to form and weld.

Presently, dual hardness armor is considered the best metallic armor available. This material is a composite steel armor consisting of two kinds of steel metallurgically bonded together. The steel on the front face, or attack side, is harder but less tough than the equally thick steel on the back face. One steel combination finding considerable application at the present time is a dual hardness steel armor designated DPSA-2 (Dual Property Steel Armor). All metallic armor is considered to have multihit capability.[4]

Ceramics

The most common ceramics used in body armor are boron carbide, aluminum oxide (alumina), and silicon carbide. These materials are stronger and lighter than most metals and would be ideal, except that none developed to date can provide multihit protection since they are excessively brittle. Usually, the hard face or attack side consists of a very hard ceramic material that has been either molded in one piece to fit the contour of the part of the body that is to be protected or has been made up as small flat plates that are carried in pockets in the armor vest. The back face, or back-up material, is normally fabricated of glass reinforced plastic (GRP) which is bonded to the ceramic by an adhesive. It should be pointed out that in order for the ceramic to function properly, it must be completely bonded to the back-up material which is less tough and brittle than the ceramic face. This is analogous to the nonshattering safety glass composite used in all modern automobiles.

[4] Multihit capability is defined as the ability of a piece of armor to withstand a second hit of the same caliber bullet traveling at the same velocity as the original bullet within two inches of the original impact.

Law enforcement agencies that are stocking or planning to acquire ceramic armor should be aware that such units are substantially weakened by being dropped or roughly handled. As supplied to the U.S. Army, ceramic armor bears the notation imprinted in letters one inch high "DO NOT DROP," and instructions are issued to logistic personnel that if dropped from any height, the armor is to be returned to the manufacturer for detailed examination to insure serviceability. This precaution is taken since dropping or otherwise damaging ceramic armor can destroy its ability to withstand first round hits.

Until such time as ceramic armor manufacturers provide police armor with "DO NOT DROP" warnings similar to those affixed to identical military models, new ceramic armor should be inspected and so marked at the time of its receipt by the law enforcement agency. In addition, ceramic armor should be utilized only be specially trained officers who have been given adequate instruction on its fragile nature. Before wearing ceramic armor, officers should inspect each segment, feeling for fractures. While it is not feasible for police officers to remove the spall shield and inspect the armor in detail, the manual palpation will often reveal major fractures of the armor. Any evidence of a break or other irregularity should cause the immediate replacement of that segment, or at least should alert the policeman to the fact that he may not be fully protected by his armor.

To further reduce the risk of damage, ceramic armor should be kept in central storage and withdrawn only when necessary. Under no circumstances should it be stored in the trunk or other parts of a squad car. Personnel withdrawing and returning ceramic armor to central storage should be held responsible for reporting any possible damage to the armor. Unless the departmental armorer is trained to detect structural damage, ceramic armor can be a risky investment for the average police agency.

Polycarbonate Resin

This material, a synthetic resin developed by General Electric Company under the trade name "Lexan," is a rigid, transparent material which is suitable for glazing and construction work, and can be produced in sections suitable for body armor. Like all polymers, it has no true melting point, but under strain the material will dissolve at about 308° F and can be poured.

Lexan is a relatively soft material and scratches easily. For this reason, it is to be treated with caution in fabricating helmet face shields or other sections where vision is of primary importance. For body armor, the susceptibility to abrasion is of less importance.

CONSTRUCTION OF BODY ARMOR

There are two basic designs represented by body armor currently in use: rigid armor and variable armor.

Rigid Armor

Armor composed of sections molded to fit a certain part of the body is called rigid armor. For example, one piece is usually molded to cover the front portion of the chest and extends part way around the sides of the upper body, while a second section is designed to cover the upper back region and extends around the sides to meet (or overlap) the front section. This design eliminates the joints present when using small individual plates of armor. Most commercially available armor is of the rigid type, constructed of glass reinforced plastic, metals, or ceramics.

Rigid ceramic armor vests are now being made for the armed forces in limited quantities and two units, the Carborundum KT and the AVCO PA500, are available for police purchase. However, this type of armor is expensive and difficult to manufacture, and problems of quality control are still present. The weight of rigid armor pieces depends on the area to be protected, but is approximately as follows:

Chest protection	10.0 pounds
Back protection	12.5 pounds
Groin protection	4.2 pounds
Coccyx protection	5.9 pounds
	32.6 pounds

This weight is for a man of average size, 67 1/2 to 70 inches tall. The total weight range of rigid ceramic armor for small to large men for full protection would be from about 29 to 35 pounds. This particular armor is rated to protect against all bullets up to and including the caliber .30 armor piercing round at muzzle velocity.

Variable Armor

This concept, on which the U.S. Army has devoted much time and money, includes the use of pockets in a nylon vest or jacket, into which overlapping armor segments or plates can be inserted. The armor plates may be ceramic-faced composites, metal, or glass reinforced plastic. The basic vest itself is made of closely woven nylon fibers and, in the medium size, has a total weight of about 5 pounds without armor plates.

As the level of threat increases, armor segments are inserted into the vest to upgrade it. Therefore, to meet the highest level of small arms threat anticipated, a point-blank caliber .30 armor piercing bullet for example, the vest with ceramic-faced plates inserted in front and back pockets would weigh from 24 to 27 pounds. In this manner, various levels of protection can be obtained from a vest than may weigh from 5 to 27 pounds.

In some cases, metallic armor plates made from titanium alloy or Hadfield manganese steel could be inserted into variable armor pockets instead of ceramic plates. However, for the same protection, the weight of a vest with metal plates would be heavier than one with ceramic segments and, therefore, metal segments would be used by law enforcement personnel only for limited purposes. An important advantage of the variable armor concept is that damaged plates can be readily replaced, and this is especially important in the case of ceramic-faced plates which have no multihit capability.

The variable armor concept would appear to offer some major advantages for police uses. For example, lightweight units for civil disorder protection against thrown objects could be upgraded in special situations to provide protection against small arms fire.

POLICE BODY ARMOR

This section will describe a number of body armor units currently marketed, or under development, by commercial sources in the United States. Figure 17, at the end of this section, summarizes selected characteristics of the armor units to be covered and provides a convenient format for comparing specific products.

While military body armor is not included in this report, certain military body armor may be declared surplus to the needs of the service and sold at very low prices by the Defense Supply Agency under the provision of Section 2576, Title 10, USC (Public Law 90-500). When considering the use of surplus armor, however, it should be noted that most military armor units are designed to protect against shell fragments rather than bullets. This results from the fact that in World War II and Korea approximately 80 percent of the casualties were produced by fragments from artillery and mortar shells and grenades. Consequently, it should *not* be assumed in the absence of comprehensive tests that military armor is suited to police applications.

Some armored vests are composed entirely of the protective armor material, while others utilize pockets in a cloth carrying garment into which the armor material is placed. In this latter group, the extent of the carrying garment may be much greater than the armored portion providing maximum rated protection. Since it is important to know the area of the body given full protection, the figures illustrating armor units in this section show in black the area giving the maximum protection claimed for that garment. The fabric, and nonprotective areas of the garment, are shown in grey. It should be noted, however, that for some units multiple layers of nylon used in areas of reduced protection can provide defense up to .38 special rounds.

For each armor unit the manufacturer or supplier makes certain claims regarding the protection afforded the wearer. In the following section, these claims are referred to as the "rated" protection. As part of a comprehensive study of body armor standards being conducted for the National Institute of Law Enforcement and Criminal Justice (LEAA) by the National Bureau of Standards, preliminary firing tests against armor were recently conducted. The results of these tests are included in the discussion of each unit of armor. A description of these tests is included in a subsequent section entitled Ballistic Testing of Body Armor.

AGRAMONTE Lancer Armored Vest

The Lancer Armored Vest is manufactured by Ed Agramonte Incorporated, Yonkers, New York, and is rated by the maker to protect against caliber .357 magnum rounds. The vest, shown in figure 4, is made entirely from ballistic nylon approximately 30 layers thick and weighs 11.6 pounds without the groin protector. The cost of this vest is $89 plus $15 for the groin piece, and it provides its maximum protection to 407 square inches in front and 484 square inches in back. It also provides full protection over the shoulders, although the sides are not covered.

The Lancer Vest did not provide protection against caliber .357 magnum lead and soft point rounds. Two out of two rounds fired penetrated. However, the vest did stop thirteen out of thirteen rounds fired from a caliber .38 special, using both lead and metal point ammunition. It also stopped five of five rounds .22 long rifle, high velocity ammunition fired from a rifle.

AVCO Vest PA 100

AVCO Special Materials Company, Lowell, Massachusetts, manufactures two types of body armor, a regular line (PA 100) and a high protective line (PA 500). The regular type, made of 11 layers of glass reinforced plastic, is available in a short vest, shown in figure 5, which is designed to be worn under clothing or in a long vest which affords groin protection. The short vest weighs only 3.25 pounds, and is rated to withstand caliber .357 magnum rounds. A back protection portion will shortly be introduced to the market. The regular AVCO vest affords its maximum protection to 267 square inches of the front of the body. The cost for the short vest is $75.

Ballistic testing of the PA 100 armor conducted by the Naval Research Laboratory showed that the armor stopped two out of two hits with caliber .22 long rifle high velocity ammunition fired

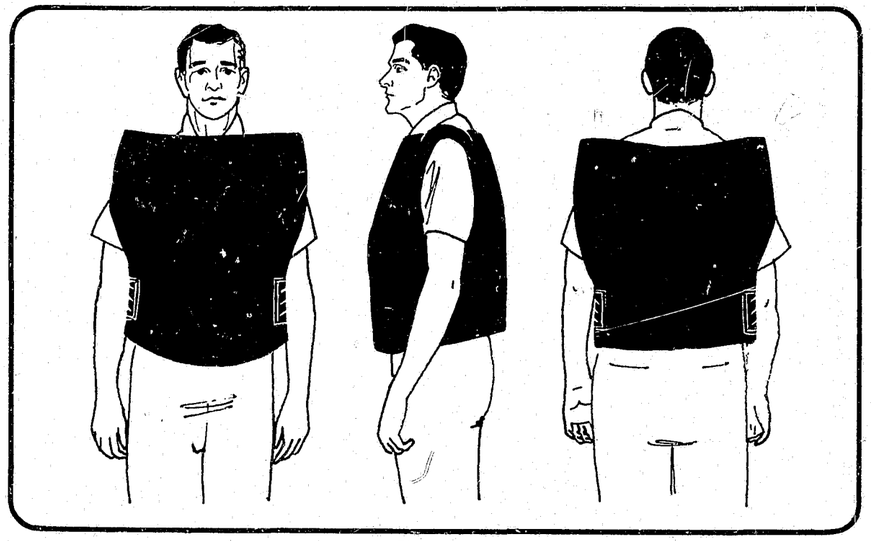

Figure 4
LANCER VEST

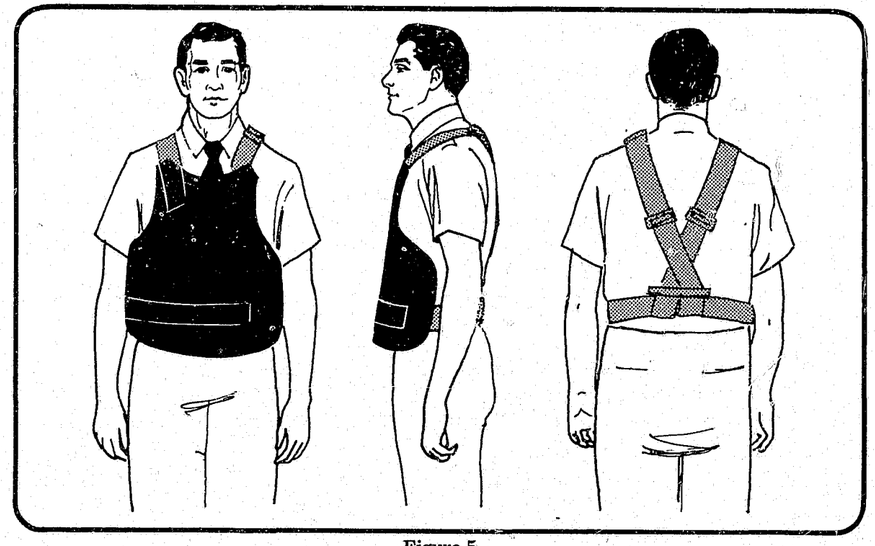

Figure 5
AVCO REGULAR ARMOR, MODEL PA 100

from a pistol, and a total of eleven out of eleven hits with caliber .38 special lead and metal point rounds. Using caliber .357 magnum lead rounds, the first of ten shots penetrated and the remainder were stopped. In a retest, the front section stopped three out of three caliber .357 magnum lead rounds.

All GRP armor produced by AVCO prior to November 1, 1970, is reported by the manufacturer to be subject to initial hit penetration which is caused by direct overlaying of the first three layers of glass rovings, and consequent exposure of resin only in the first lamina of the armor. All armor produced since November 1, 1970, is reportedly examined to assure that this fault is not present. The date of production should be ascertained from the manufacturer or supplier.

AVCO Vest PA 500

The AVCO high protective line of vests, illustrated in figure 6, is made of the same glass reinforced plastic as the regular vest but is faced with ceramic (alumina) and weighs 36.25 pounds. It is rated to withstand caliber .30 armor piercing rounds at velocities in the region of 3,000 feet per second. Like all ceramic armors, this unit has no multihit capacity. The vest gives maximum protection over approximately 318 square inches in the front and 217 square inches in the back. It is available in small, medium, and large sizes and costs (with groin protector) $340 per set.

When the PA 500 armor was ballistically tested, it was found that the front section stopped three out of three caliber .30 armor piercing direct hits, but the back section failed to stop three rounds of the same ammunition. The manufacturer claimed that the failure of the back section was due to

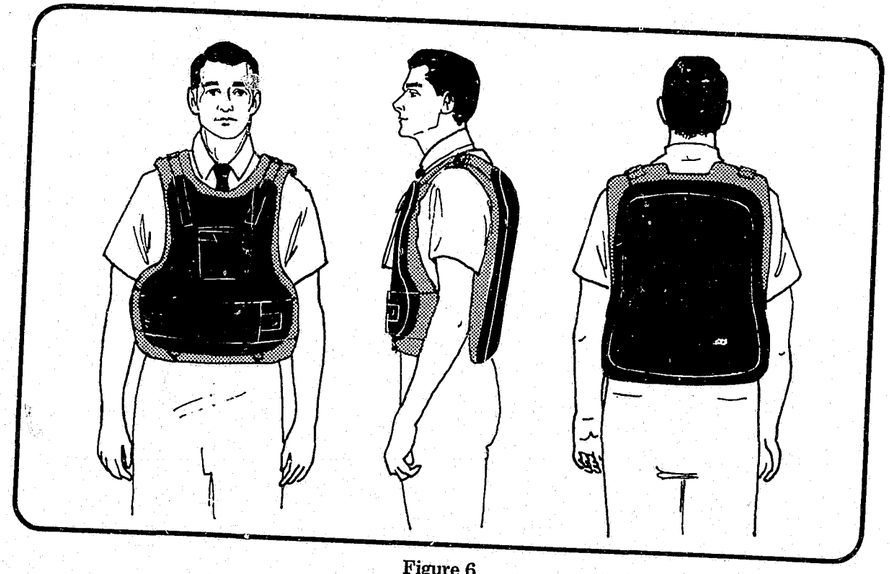

Figure 6
AVCO HIGH PROTECTIVE VEST, MODEL PA 500

the armor having been cracked by rough handling and a retest was scheduled. Upon retesting at the manufacturer's range, a rear section of PA 500 armor, selected at random from the production line successfully withstood the impact of three out of three rounds of caliber .30 armor piercing ammunition.

CARBORUNDUM KT-1 Vest

The Carborundum Company, Niagara Falls, New York, manufactures a line of ceramic body armor which is rated to protect against caliber .30 armor piercing ammunition. This armor, which protects the chest, back, and groin, is made of Doron panels bonded to hard ceramic (silicon carbide). These composite plates are inserted into pockets in a nylon carrier that distribute the weight efficiently on the shoulders of the wearer. The KT-1 vest provides maximum protection to 277.5 square inches in front and 206.8 square inches in back and weighs 35.3 pounds.

The Carborundum KT-1 vest, illustrated in figure 7, is available in regular, large, and extra-large sizes. The entire assembly, including front, back, groin, and coccyx sections plus a carrying case, markets for approximately $500.

When ballistically tested, this ceramic vest failed to stop a caliber .30 armor piercing round in the groin section. The front section stopped three out of four caliber .30 armor piercing rounds and the coccyx section stopped a caliber .30 armor piercing round. The back section stopped only two out of four rounds of caliber .30 armor piercing ammunition fired, the failures occurring on rounds 3 and 4, which is an example of the recognized lack of multihit capability of ceramic armor.

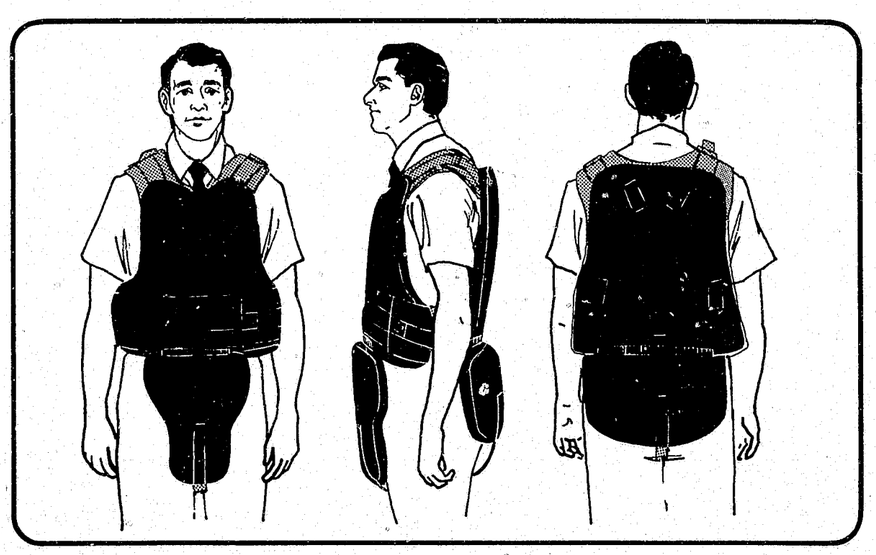

Figure 7
KT-1 ARMOR

DAVIS Vest, Model 6003-3

Davis Aircraft Products Company, Northport, Long Island, New York, manufactures a rather extensive line of armored vests. Their model 6003-3, shown in figure 8, is rated effective against caliber .357 magnum, caliber .44 magnum, and 9 mm parabellum bullets, as well as deer slugs, and 00 and No. 4 buckshot from 12-gauge shotguns. It protects the front, back, and groin area and weighs, exclusive of the groin section, 13 pounds, which is rather light for a steel-plate vest protecting 182.5 square inches of the front and 181.5 square inches of the back of the body. The vest, composed of Hadfield steel plate and 12 layers of ballistic nylon, costs $135.

The ballistics test of this protective outfit showed that the vest stopped seventeen hits out of seventeen rounds fired using caliber .357 magnum lead, metal point and soft point bullets. It also stopped two out of two rounds of caliber .44 magnum lead ammunition.

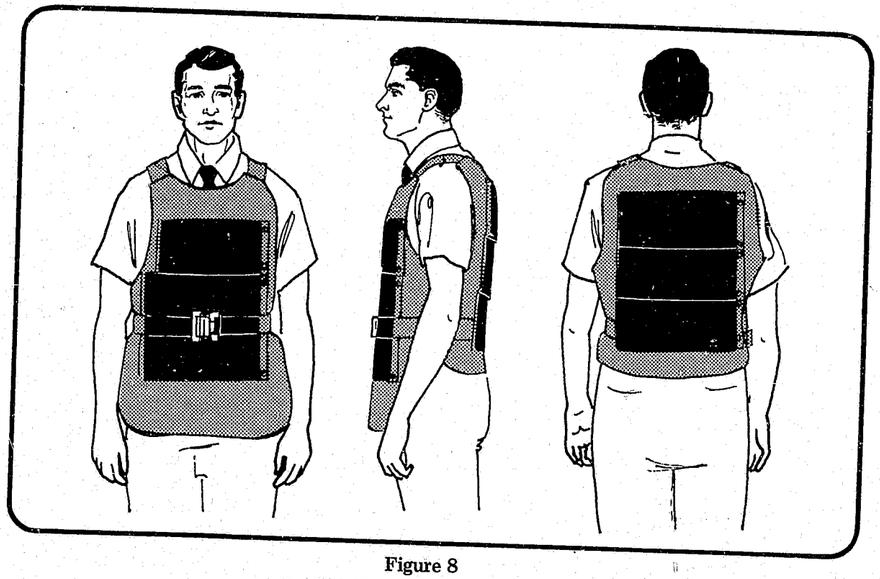

Figure 8
DAVIS VEST, MODEL 6003-3

DAVIS Vest, Model 6003-1

The model 6003-1 vest, which is composed of 12 layers of ballistic nylon, weighs, exclusive of the groin section, 8 pounds, and is rated to stop caliber .38 special rounds. In design it is identical to the model 6003-3 illustrated in figure 8, but does not have the steel plates found in the 6003-3 armor. The model 6003-1 provides its maximum protection to 385 square inches in front and 333 square inches in the rear and markets for $100 per set.

In tests, the model 6003-1 stopped ten of ten rounds of caliber .38 special lead, and one of three rounds of caliber .38 special metal point ammunition.

DAVIS Vest, Model 6003-5

The 6003-5 model, which is also identical in appearance to the 6003-3, is composed of three layers of steel and 12 layers of ballistic nylon. It markets for $140 with an additional $20 for the groin piece and is rated to stop caliber .30 carbine rounds, as well as caliber .357 magnum and caliber .44 magnum rounds. It provides maximum protection to 130 square inches in front and 130 square inches in the rear. The front and back sections together weigh 23 pounds and the groin section weighs an additional 4.5 pounds.

In tests, the model 6003-5 stopped two of two rounds of caliber .357 lead and metal point ammunition, and two of two rounds of caliber .44 magnum lead rounds. It also stopped six of six rounds of caliber .30 carbine metal point rounds, but only six of nine rounds of caliber .30 carbine soft point ammunition fired.

DAVIS Vest, Model 6010-2

The Model 6010-2 also is designed for wear under outer clothing and is constructed of 12 layers of ballistic nylon without steel plates. The 6010-2 has, in addition, an outer covering of black "Shok cloth" which in effect increases the protection to 14 layers of ballistic material. Model 6010-2 gives its maximum protection to 395 square inches in front and 355 square inches in the rear and weighs 6.25 pounds, exclusive of the 1.75-pound groin section. It markets for $100 per set plus $12.50 for the groin piece. This vest is rated to withstand the impact of caliber .38 special rounds.

The model 6010-2 stopped ten of ten rounds of caliber .38 special lead ammunition, but only one of four rounds of caliber .38 special metal point ammunition.

DAVIS Vest, Model 6007-4

The model 6007-4, designed to be worn under outer clothing, is constructed of one layer of steel and 12 layers of ballistic nylon. It weighs 11.5 pounds, exclusive of the three-pound groin piece, and provides maximum protection to 130 square inches in front and 130 square inches in the rear. Model 6007-4 markets for $120 per set plus $15 for the groin section. It is rated by the manufacturer to stop a caliber .357 magnum lead, soft point or metal piercing round.

In tests, the model 6007-4 stopped caliber .357 magnum lead, metal point, and soft point bullets in thirteen of thirteen rounds fired, but stopped only one of four of the caliber .44 magnum rounds fired.

DEFENSOR Vest, Model V1-A

An armored vest similar to the Davis vest is available through Defensor Protective Equipment, Incorporated, Media, Pennsylvania. This vest, model V1-A, is illustrated in figure 9 and weighs 3.9 pounds. It is made of overlapping Doron armor plates which are covered by 12 layers of nylon material with reinforced webbing. It is designed to protect vital frontal body areas from thrown objects, bricks, bottles, and knives, as well as from bullets traveling up to 855 feet per second, such as the caliber .38 special. The vest provides maximum protection over 261 square inches in front only and costs $68 with groin protection.

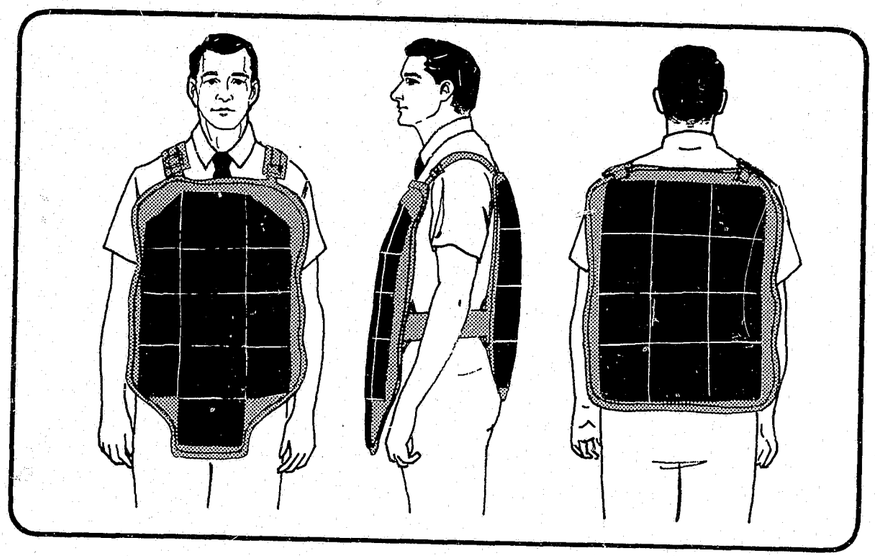

Figure 9
DEFENSOR VEST, MODEL V1-A

The Defensor vest, model V1-A, stopped ten of ten rounds fired from caliber .38 special pistol using metal point rounds. However, two out of two rounds of 12-gauge 00 buckshot penetrated, with one of the impacts blowing the Doron plates through the back of the vest. It also failed to stop two of two .357 magnum rounds.

DEFENSOR Vest, Model V2-A

The Defensor V2-A is identical to the V1-A unit, except for an additional Doron layer that increases the rated protection to handgun bullets up to and including the 9 mm parabellum and the standard caliber .357 magnum load with a 158 grain lead bullet. It weighs 12 pounds and provides 261 square inches of protection in front and 288 square inches of protection in the rear and costs $125 per set. In tests, the model V2-A stopped fifteen of sixteen rounds of caliber .357 magnum lead, metal point, and soft point ammunition. It failed to stop a caliber .30 metal point round.

FEDERAL-SPOONER Vest, Model P

The Federal-Spooner-System of armored vests, which is available from Federal Laboratories, Incorporated, Saltsburg, Pennsylvania, is designed to defeat the threat of handgun bullets up through caliber .357 magnum ammunition. The model P full vest, illustrated in figure 10, weighs approximately 16.5 pounds and provides protection to the torso and groin from the front, side, and rear. It provides maximum protection to 266.5 square inches in front and 318 square inches in the rear and costs

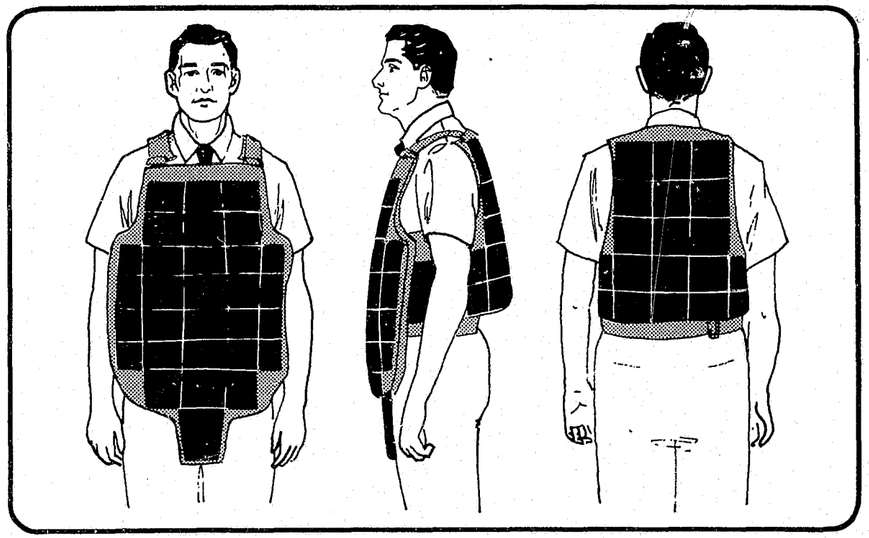

Figure 10
FEDERAL-SPOONER VEST, MODEL P

the rear and costs $150 for the complete set. This vest is constructed of two overlapping steel armor plates sewn into pockets which are made of three layers of ballistic nylon. The model P vest is flexible and is rated to withstand handgun bullets with a velocity up to 1,430 feet per second, about the equivalent of a caliber .357 magnum at 25 yards.

In tests, the model P armor stopped twenty-eight out of twenty-nine rounds fired from a caliber .357 magnum pistol using lead, metal point, and soft point ammunition, but failed to stop caliber .30 carbine metal point rounds or a 12-gauge rifled slug.

FEDERAL-SPOONER Vest, Model C (708)

The model C is composed of a layer of steel sewn into a carrying vest made of three layers of ballistic nylon and is rated to provide protection against a caliber .38 special round. The model weighs 12.6 pounds and provides maximum protection to 266.5 square inches in front and 318 square inches in back. It markets for $125. A groin section is available on special order.

Model C stopped eleven of eleven rounds of caliber .38 special lead and metal point ammunition, but failed to stop a caliber .357 magnum metal point round.

FEDERAL-SPOONER Vest, Model C (708F)

The model C (708F), which is the front section of model C, is designed to be worn under clothing and weighs only five pounds. Like model C, it is rated to defeat caliber .38 special rounds. It sells for $63 and provides protection to 266.5 square inches in front only.

Model C (708F) stopped ten of ten rounds of caliber .38 special lead and metal point ammunition, but failed to stop a round of caliber .357 magnum metal point ammunition.

GOEC Barrier Vest, Models 120 & 217

The General Ordnance Equipment Corporation (a subsidary of Smith and Wesson), Pittsburgh, Pennsylvania, markets body armor which is sold under the trade name "Barrier Vest." There are three models available: model 217, model 120, and model 434 C.

The model 217, shown in figure 11, is made of molded steel bonded to ten layers of ballistic nylon in the front section, and the back section is composed of one layer of molded steel bonded to seven layers of ballistic nylon, for a total weight of 9.25 pounds. There is also a groin section of the same composition which weighs 2.3 pounds and costs $15. The vest costs $120 and provides maximum protection to 125 square inches in front and 125 square inches in back. The model 217 is rated to withstand caliber .357 magnum ammunition.

Model 120 is identical in design to model 217, except the back section does not contain the steel plate and consists of ten layers of ballistic nylon only. The front and back sections weigh 8.5 pounds and cost $105. The groin section contains the steel plate, weighs 2.3 pounds, and costs $15. The front section provides maximum protection of 125 square inches and is rated by the manufacturer to withstand caliber .357 magnum rounds.

The front section of model 217 stopped fourteen of fourteen rounds fired from a caliber .357 magnum, using lead, metal point, and soft point ammunition. The back section of model 217 stopped twelve of twelve rounds caliber .357 lead, metal point, and soft point ammunition.

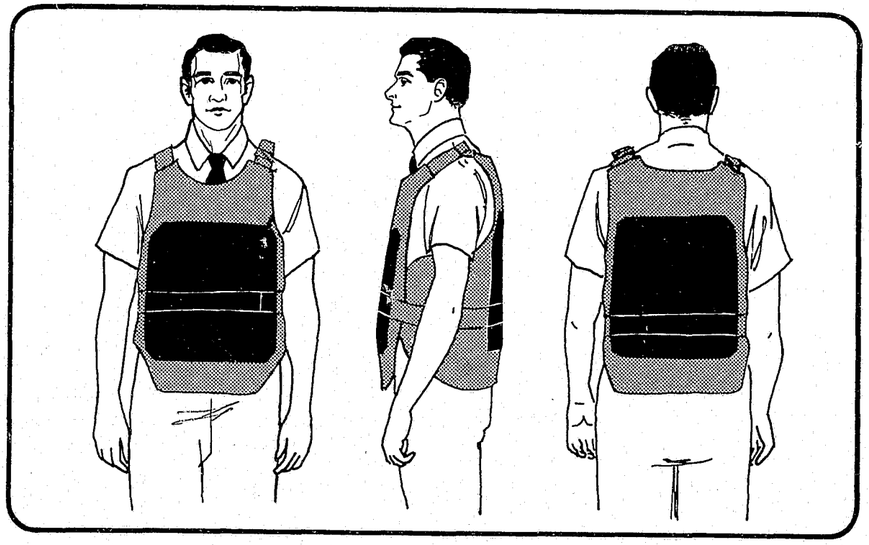

Figure 11
GOEC BARRIER VEST, MODEL 217

The front section of model 120 stopped thirteen of thirteen rounds of caliber .357 magnum lead, soft point, and metal point ammunition. Two of two rounds caliber .357 magnum lead ammunition were stopped by the groin section of model 120.

GOEC Barrier Vest, Model 434C

GOEC's model 434C, illustrated in figure 12, is composed of three layers of steel bonded to 10 layers of ballistic nylon in all three sections, front, rear and groin, and weighs 20 pounds. It sells for $160 including groin protector and provides maximum protection to 125 square inches in front and 125 square inches in back. The model 434C armor is rated to withstand caliber .357 magnum and caliber .30 carbine ammunition.

In addition to defeating five out of five caliber .357 magnum lead, metal point and soft point rounds, the model 434C also provided protection against three of three rounds of caliber .30 carbine metal point ammunition, and three of four caliber .30 carbine soft point rounds fired.

IMPERIAL Supershield (Prototype)

This very recent development of the Imperial Protector Company of Compton, California, is manufactured of polycarbonate resin. It is transparent and is designed to be worn routinely under the uniform. The Supershield, shown in figure 13, may be fabricated in ¼-inch thickness, or in two laminated ¼-inch sheets to give an overall thickness of half an inch. It is also available in

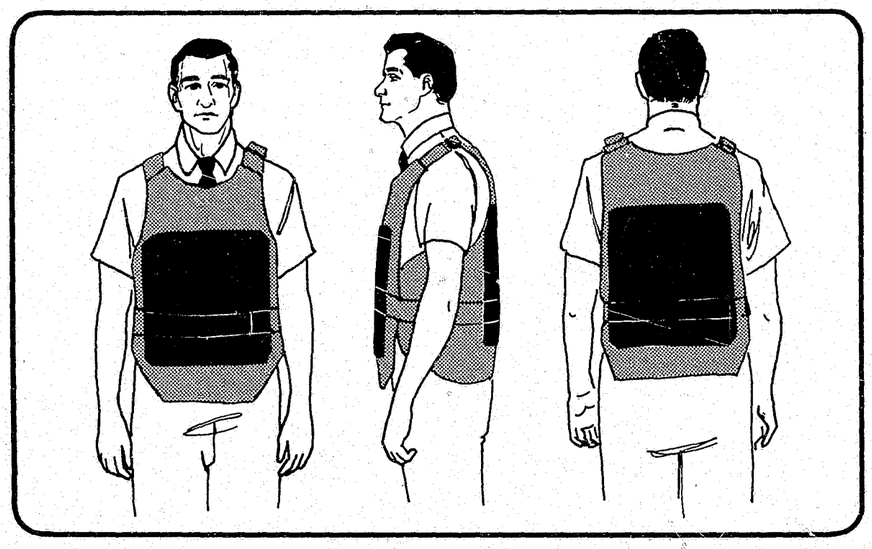

Figure 12
GOEC BARRIER VEST, MODEL 434C

$^3/_8$-inch-thick sections. The front section of the ½-inch-thick shield weighs seven pounds. A back section is now under design. In the ½-inch configuration, the Supershield is rated to withstand the caliber .44 special, the caliber .38 special, and the caliber .45 a.c.p. and to provide protection against the caliber .22 long rifle. However, even the $^3/_8$-inch section will not provide protection against the magnum or high velocity rifle loads. The Supershield front section provides protection to 226 square inches of the body, and weighs four pounds. The manufacturer estimates that this armor will market for under $50.

As claimed by the manufacturer, the $^3/_8$-inch Supershield stopped eleven out of eleven lead and metal point rounds fired from a caliber .38 special, and three out of three rounds of caliber .22 long rifle, high velocity ammunition fired from a pistol. It failed to stop either a caliber .357 magnum or two caliber .22 long rifle high velocity round fired from a rifle.

ROLLS ROYCE-Colt Security Vest

Colt Industries, Hartford, Connecticut, recently obtained the U.S. distributing license from the manufacturers, Rolls Royce (Composite Materials) of England, for this armor called the Security Vest. Figure 14 illustrates this garment which consists of a chest protector, a back protector, and an optional pelvis protector and costs $200. Each portion is made of 10 laminated sections of GRP backed by ¼ inch of foam rubber. The total weight is 11.31 pounds and the garment provides maximum protection to 230.5 square inches in front and 141 square inches in back. The Security Vest is rated to stop 7.62 Mauser, 9 mm, 7.62 mm AK47 and caliber .357 magnum rounds.

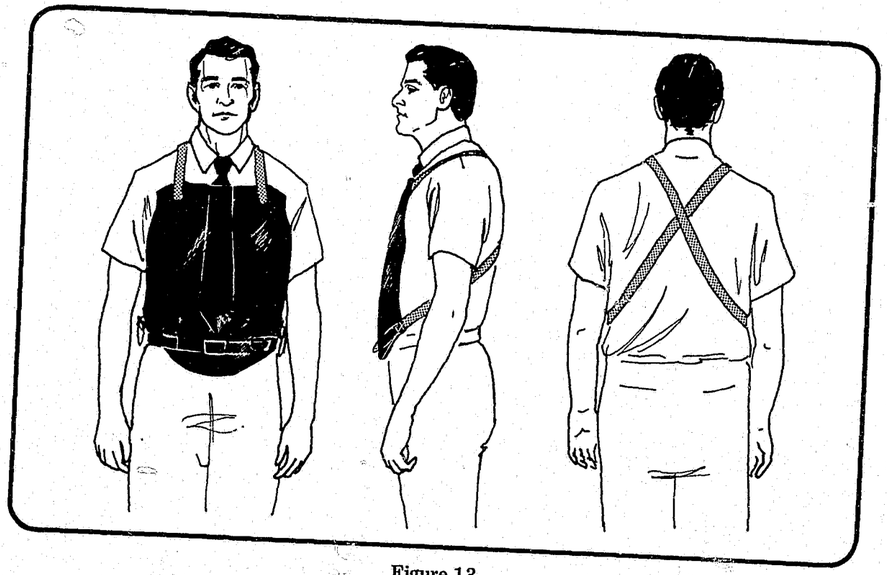

Figure 13
SUPERSHIELD

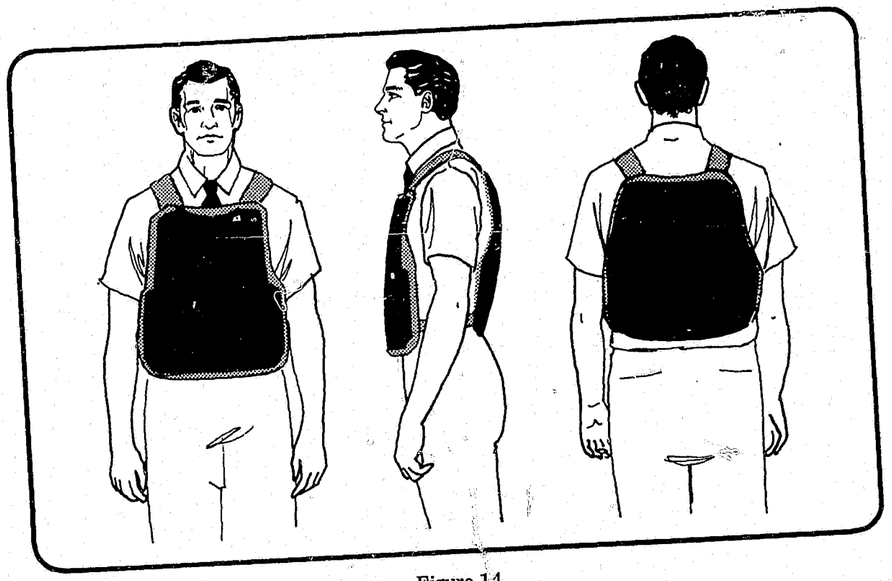

Figure 14
ROLLS ROYCE SECURITY VEST

A heavier, ceramic composite version called the Combat Vest has the same dimensions but, naturally, is heavier and thicker. It is rated to stop caliber .30 high velocity rifle bullets.

In tests, the Security Vest stopped thirteen out of thirteen rounds of lead, metal point, and soft point ammunition fired from a caliber .357 magnum pistol and also stopped three of four rounds from a caliber .44 magnum using lead ammunition. It failed to stop either a caliber .30 metal point round or a rifled slug from a 12-gauge shotgun.

SKYLINE Armored Vest, Model SK 426328 (Prototype)

This rigid glass reinforced plastic vest is made in three parts to protect the chest, back, and groin and is available in three sizes, small, medium, and large. The material is 3/8 inch thick and has a nominal weight of 8 to 15 pounds for the front and back sections. The armored sections are carried in nylon pockets. The Skyline Vest is rated to withstand a caliber .357 magnum 158-grain bullet at 20 feet from the muzzle as well as the caliber .44 magnum Norma round.

This armor satisfactorily stopped a caliber .357 magnum lead round and also stopped ten out of ten rounds of caliber .44 magnum ammunition using lead rounds. It also stopped a rifled slug from a 12-gauge shotgun.

TABOR-Colt Vest

The Tabor vest is made by the P.M. Tabor Company of Laguna Beach, California, and consists of three pieces designed to protect the front, back, and groin areas. This vest is shown in figure 15, and

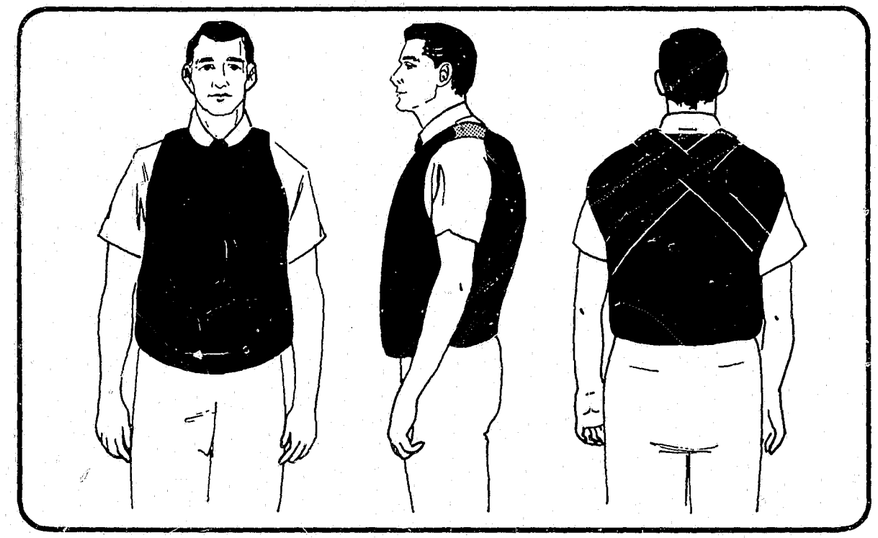

Figure 15
TABOR VEST

each section is made of molded glass reinforced plastic, approximately ¼ inch thick, backed by foam rubber. The manufacturer states that the Tabor vest will withstand the caliber .38 special, the caliber .45 a.c.p. and the caliber .22 long rifle. The complete unit (front, back, and groin) weighs 16 pounds and markets for $176. The Tabor vest protects approximately 301.5 square inches in front and 400 square inches in the back. The P.M. Tabor line of equipment is now marketed through the Colt Firearms Company of Hartford, Connecticut.

The Tabor vest on ballistic testing stopped ten out of ten rounds fired from a caliber .38 special pistol using metal point ammunition and also stopped three out of three rounds of caliber .22 long rifle high velocity ammunition fired from a rifle. It failed to stop a caliber .357 magnum metal point round.

TRANSCON Armored Vest, Model 401 V

The Transcon Manufacturing Company of Los Angeles, California, markets two armored vests: models 201V and 401V. Model 201V weighs 7.5 pounds with front and back plates and provides maximum protection over 310 square inches in front, and 281 square inches in back. It is rated by the manufacturer to defeat caliber .45 a.c.p. and caliber .38 special rounds. The cost is $49 for front and back protection; a groin protector is available for $20 additional.

The model 401V weighs 14.2 pounds for the front and back portions of the assembly and provides protection over 310 square inches in front and 281 square inches in back. Figure 16 illustrates the model 401V. According to the manufacturer, it will withstand the 9 mm parabellum,

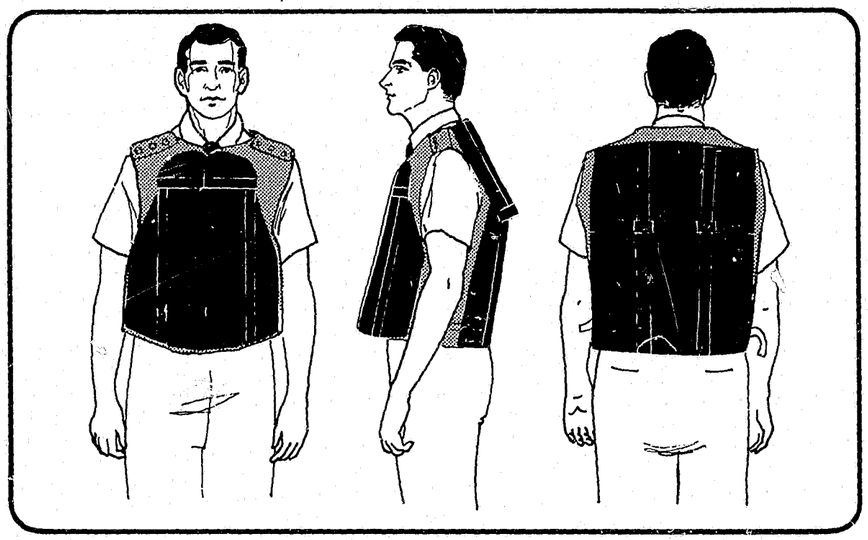

Figure 16
TRANSCON VEST, MODEL 401V

the caliber .357 magnum, and caliber .22 long rifle ammunition. The cost is $69 for the front and back protection and a groin protector is available for an additional $30.

Both models are made of Doron plates carried in pockets in the nylon carrier vest. Metal hinge plates cover the areas where armor plates butt together. The model 401V armor stopped twelve out of thirteen rounds of caliber .357 magnum using lead, metal point and soft point ammunition, but did not stop a caliber .30 carbine round. When fired at with 00 buckshot from a 12-gauge shotgun it stopped the shot, but the back of the vest was torn and the Doron plates fell out. The model 201V was not tested.

BALLISTIC TESTING OF BODY ARMOR

During January, 1971, 23 commercially available body armor units reporting the products of 12 manufacturers were ballistically tested at the Naval Research Laboratory, Washington, D.C.; this was done under the direction of the Law Enforcement Standards Laboratory which the National Bureau of Standards is operating under a grant from the National Institute of Law Enforcement and Criminal Justice, Law Enforcement Assistance Administration, United States Department of Justice. The previously described armor units were among those tested.

The various makes of armor were divided into three main groups:

Group A	–	Rated to resist caliber .38 special
Group B	–	Rated to resist caliber .357 magnum
Group C	–	Rated to resist caliber .30 AP

MANUFACTURER	MODEL	AREA ARMORED FRONT (Square Inches)	AREA ARMORED BACK (Square Inches)	WEIGHT (Pounds)	COST	CONSTRUCTION	PROTECTION CLAIMED	PROTECTION TEST RESULTS	EMPLOYMENT TIME (Seconds) FIRST TRY	EMPLOYMENT TIME (Seconds) SECOND TRY	EMPLOYMENT TIME (Seconds) VEHICLE	BALLISTIC DEFORMATION (Inches) WIDTH x DEPTH ROUND	BALLISTIC DEFORMATION (Inches) WIDTH x DEPTH MINIMUM	BALLISTIC DEFORMATION (Inches) WIDTH x DEPTH MAXIMUM
AGRAMONTE	Lancer	407	484	Front and back—11.6 Groin—1.25- (varies 1.5 with size)	Front and back—$89 Groin—$15	Front, back, and groin—30 layers of ballistic nylon	.357 magnum	Front section failed to stop 2 of 2 rounds .357 magnum L, SP and stopped 13 of 13 .38 special L, MP and 5 of 5 rounds LRHV(R)	8.8	9.0	15.8	.38	0	2 1/4x7/8
AVCO	PA 100	267		Front—3.25 Groin—special order only	Front—$75 Groin—special order only	Front—11 layers GRP Groin—11 layers GRP	.357 magnum	Front section stopped 9 of 10 rounds .357 magnum L and 11 of 11 rounds .38 special L, MP. (First round of .357 magnum penetrated.) In retest, stopped 3 of 3 rounds .357 magnum L.	85.4	15.4	22.0	.357	1x1/4	1x1/4
AVCO	PA 500	318	217	Front and back—36.2 Groin—7	Front and back—$340 Groin—$70	Front, back, and groin—multiple layers GRP plus ceramic.	.30 AP(R)	Front section stopped 3 of 3 rounds .30 APM2(R). Back section stopped 0 of 3 rounds .30 APM2(R).	109.6	24.8	23.4	Not determined		
CABORUNDUM	KT-1	277.5	206.8	Front—16 (med.) Back—19.3 (med.) Groin—6.5 Coccyx—6	Front—$185 Back—$200 Groin—$35 Set plus case—$445 Coccyx—$75	Front and back—Doron (GRP) and ceramic.	.30 AP(R)	Front section stopped 3 of 4 rounds .30 APM2(R). Back section stopped 2 of 4 rounds .30 APM2(R) with rounds 3 and 4 penetrating. Groin section stopped 0 of 1 round .30 APM2(R). Coccyx section stopped 1 of 1 round .30 APM2(R).	77.0	39.2	25.8	Not determined		
DAVIS	6003-1	385 (cloth only)	333 (cloth only)	Front and back—8.6 Groin—1.25	Front and back—$100 Groin—$12.50	Front, back, and groin—12 layers of ballistic nylon.	.38 special	Front section stopped 10 of 10 rounds .38 special L, but only 1 of 3 rounds .38 special MP.	Same design as Model 6003-3			.38	1x1/4	2x3/4
DAVIS	6003-3	182.5	181.5	Front and back—13 Groin—2.25	Front and back—$120 Groin—$15	Front, back, and groin—1 layer steel plus 12 layers ballistic nylon.	.357 magnum	Front section stopped 17 of 17 rounds .357 magnum and 2 of 2 rounds .44 magnum.	11.2	17.2	23.4	.357	0	3x1
DAVIS	6003-5	130	130	Front and back—23 Groin—4.5	Front and back—$140 Groin—$20	Front, back, and groin—12 layers ballistic nylon plus 3 layers of steel.	.357 magnum	Front section stopped 2 of 2 rounds .357 magnum, 2 of 2 rounds .44 magnum, 6 of 6 rounds .30 carbine, MP, and a 12-gauge rifled slug.	Same design as Model 6003-3			.30 carbine	2x1/4	2x1
DAVIS	6007-4	130	130	Front and back—11.5 Groin—3	Front and back—$120 Groin—$15	Front, back, and groin—12 layers ballistic nylon plus 1 layer of steel.	.357 magnum	Front section stopped 16 of 16 rounds .357 magnum L, MP, SP, but only 1 or 4 rounds .44 magnum L.	Same design as Model 6003-3			.357	3/4x1/4	2x1/2
DAVIS	6010-2	395 (cloth only)	355 (cloth only)	Front and back—6.25 Groin—1.75	Front and back—$100 Groin—$12.50	Front, back, and groin—12 layers ballistic nylon plus outer covering of "Shok cloth."	.38 special	Front section stopped 10 of 10 rounds .38 special L and 1 of 4 rounds .38 special MP.	Same design as Model 6003-3			.38	2x3/8	2x3/4
DEFENSOR	V1-A	261	0	Front and groin—3.9	Front and groin—$68	Front and groin—12 layers of ballistic nylon plus 1 Doron (GRP) plate.	.38 special	Front section stopped 10 of 10 rounds .38 special MP, but 0 of 2 rounds .357 magnum.	20.4	46.6	29.8	.38	3x1/4	3x1/4
DEFENSOR	V2-A	261	288	Front, back, and groin—12	Front, back, and groin—$125	Front and back—12 layers of ballistic nylon plus 2 Doron (GRP) plates.	.357 magnum	Front section stopped 15 of 16 rounds .357 magnum L, MP, SP, but failed to stop 1 round .30 carbine MP.	16.4	11.2	37.2	.357	0	2x1/2

Figure 17
BODY ARMOR SUMMARY CHART

MANU-FACTURER	MODEL	AREA ARMORED FRONT (Square Inches)	BACK (Square Inches)	WEIGHT (Pounds)	COST	CONSTRUCTION	PROTECTION CLAIMED	PROTECTION TEST RESULTS	EMPLOYMENT TIME (Seconds) FIRST TRY	SECOND TRY	VEHICLE	BALLISTIC DEFORMATION (Inches) WIDTH x DEPTH ROUND	MINIMUM	MAXIMUM
FEDERAL-SPOONER	P	266.5	318	Front, back, and groin–16.5	Front, back, and groin–$150	Front and back–2 overlapping steel plates in nylon pockets plus 3 layers of ballistic nylon.	.357 magnum	Front section stopped 28 of 29 .357 magnum L, MP, SP. Failed to stop a .30 carbine MP round and a 12-gauge rifled slug.	15.6	24.0	44.6	.357	0	1 1/2x1/2
FEDERAL-SPOONER	C (708)	266.5	318	Front and back–12.6 Groin–Special order only	Front and back–$125 Groin–Special order only	Front and back–1 layer of steel plate in nylon pockets plus 3 layers ballistic nylon.	.38 special	Front section stopped 11 of 11 rounds .38 special L, Mp. Failed to stop a .357 magnum MP round.	21.6	16.6	50.4	.38	less than 1/4	less than 1/4
FEDERAL-SPOONER	C (708F)	266.5		Front–5	Front–$63	Front–1 layer of steel plate in nylon pockets.	.38 special	Front section stopped 10 of 10 rounds .38 special L, MP. Failed to stop a .357 magnum MP.	12.6	12.0	20.0	.38	0	0
GOEC	217	125	125	Front and back–9.25 Groin–2.3	Front and back–$120 Groin–$15	Front and groin–1 layer of steel plus 10 layers of ballistic nylon. Back–1 layer of steel plus 7 layers of ballistic nylon.	.357 magnum	Front section stopped 10 of 10 rounds .357 magnum L, MP, SP. Back section stopped 12 of 12 rounds .357 magnum L, MP, SP.	11.2	22.6	23.2	.357	1/2x1/4	2 1/8x1
GOEC	120	125	0 (cloth only)	Front and back–8.5 Groin–2.3	Front and back–$105 Groin–$15	Front and groin–1 layer of steel plus 10 layers of ballistic nylon. Back–10 layers of ballistic nylon only.	.357 magnum (Front only)	Front section stopped 13 of 13 rounds .357 magnum L, MP, SP. Groin section stopped 2 of 2 rounds .357 magnum L.	20.4	24.8	61.4	.357	1 1/4x3/8	3x7/8
GOEC	434C	125	125	Front and back–16 Groin–4	Front and back–$140 Groin–$20	Front, back, and groin–3 layers of steel plus 10 layers ballistic nylon.	.30 carbine (R) .357 magnum	Front section stopped 3 of 3 rounds .30 carbine MP, but only 3 of 4 rounds .30 carbine SP. Also stopped 5 of 5 rounds .357 magnum L, MP, SP.	43.4	23.0	31.2	.30 carbine	1 3/4x1/2	2 1/4x1
IMPERIAL	Supershield	226	0	Front–4	Prototype	Polycarbonate resin.	.38 special	Front section stopped 11 of 11 .38 special L, MP and 3 of 3 rounds .22 LRHV(P). Failed to stop a .357 magnum round and 2 .22 LRHV(R).	6.2	35.4	56.4	.38	less than 1/4	less than 1/4
ROLLS ROYCE- Colt	Security	230.5	141	Front and back–8.88 Groin–2.43	Front, back, and groin–$200	Front, back, and groin–10 layers of compressed GRP.	.357 magnum	Front section stopped 13 of 13 rounds .357 magnum L, MP, SP, and 3 of 4 rounds .44 magnum L. Failed to stop a .30 carbine MP round and a 12-gauge rifled slug.	12	12	9.2	.357	0	o
SKYLINE	SK 426328	236		Front and groin–7.3	Prototype	GRP and nylon carrier.	.44 magnum	Front section stopped 10 of 10 rounds .44 magnum L, 1 round .357 magnum and a 12-gauge rifled slug.	Carrier not supplied			.44	4x3/4	4x3/4
TABOR-Colt	Tabor	301.5	400	Front and back–15 Groin–1	Front and groin–$88 Back–$88	GRP	.38 special	Front section stopped 10 of 10 rounds .38 special MP and 3 of 3 rounds .22 LRHV(R). Failed to stop 1 round .357 magnum MP.	20.8	16.6	34.8	.38	0	0
TRANSCON	401 V	310	281	Front and back–14.2 Groin–3	Front and back–$69 Groin–$30	Front, back, and groin–2 Doron (GRP) plates and ballistic nylon.	.357 magnum	Front section stopped 12 of 13 rounds .357 magnum L, MP, SP, but failed to stop 1 round .30 carbine MP.	10	20	41.4	.357	2x3/4	2 1/4x1 1/2

Abbreviations: AP = Armor piercing; MP = Metal point; SP = Soft point; L = Lead; R = Rifle; P = Pistol; GRP = Glass reinforced plastic; LRHV = Long rifle, high velocity

Figure 17 (Continued)
BODY ARMOR SUMMARY CHART

Group A included the following brands and models of armor:

Brand		Model
DAVIS	–	6003-1
DAVIS	–	6010-2
DEFENSOR	–	V1-A
FEDERAL-SPOONER	–	C (708)
FEDERAL-SPOONER	–	C (708 F)
GOEC	–	120 (Back)
IMPERIAL	–	Supershield
TABOR-Colt	–	Tabor Vest

Group B included the following brands and models of armor:

Brand		Model
AGRAMONTE	–	Lancer
AVCO	–	PA 100
DAVIS	–	6003-3
DAVIS	–	6007-4
DAVIS	–	6003-5
DEFENSOR	–	V2-A
FEDERAL-SPOONER	–	P
GOEC	–	217
GOEC	–	120 (Front)
GOEC	–	434C
ROLLS ROYCE-Colt	–	Security
SKYLINE	–	SK 426328
TRANSCON	–	401 V

Group C included the following brands and models of armor:

Brand		Model
AVCO	–	PA 500
CARBORUNDUM	–	KT-1

Test Procedure

Each piece of armor tested was placed on a target rack and held in place, normal to the trajectory of the bullet, by C-clamps. A 3-by 6-by 6-inch block of modeling clay, at room temperature, was placed behind the armor and in immediate contact with it. The purpose of the modeling clay was to record the ballistic deformation of the armor in the event the impacting round deformed but did not penetrate the armor. The target array was backed up with a metal deflecting screen designed to stop rounds which penetrated both the armor and the modeling clay.

The weapon was placed in a stand, where it was held firmly in place and fired by means of a lanyard from an adjoining corridor. The test equipment is illustrated in figure 18.

Velocity of Bullets

For the firing of the armor tests cited in this report, chronographs were used for velocity determination. Two velocity screens separated by a distance of two feet were used to start and stop a 1.6-megahertz time interval counter. In most instances, two interval counters were used to provide a check on counter response. The velocity screens consisted of a silver line network on

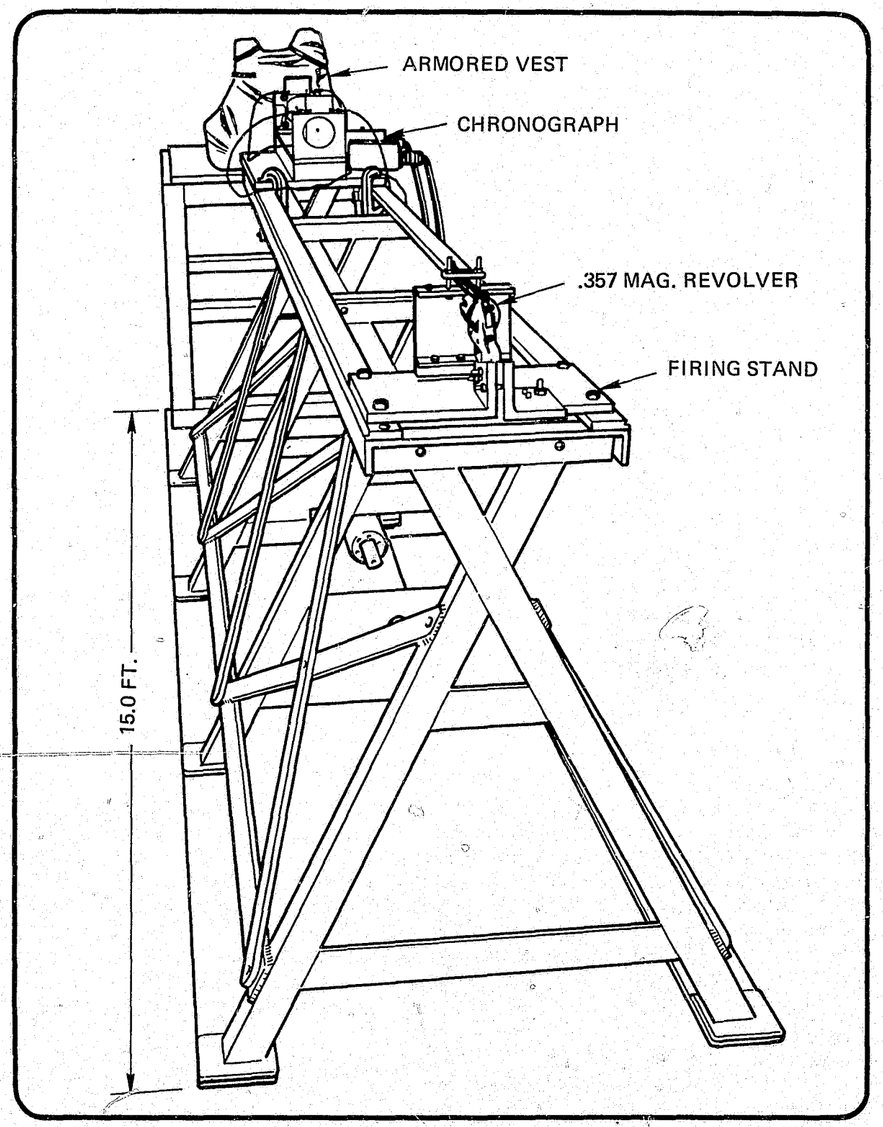

Figure 18
TESTING STAND

approximately .004-inch-thick paper. The projectile passing through a screen breaks a circuit which generates a pulse that starts or stops the interval counter. The circuit between the velocity screens and the interval counter includes matched lines from start and stop screens.

Velocities recorded during tests were the measured velocities and represent the average velocity between the two velocity screens. Such velocities are normally referred to as instrument velocities. The velocity at impact with the target is lower than the instrument velocity by the amount of air drag over the distance from the midpoint between the screens to the target, which was approximately four feet for these tests.

Penetration Data

The results of the ballistic testing (penetration) are summarized in figures 19, 20 and 21. The following ammunition abbreviations are used in all three figures:

LRHV	–	Long rifle, high velocity
L	–	Lead
MP	–	Metal point
SP	–	Soft point
AP	–	Armor piercing
L(P)	–	Lead, fired from pistol
L(R)	–	Lead, fired from rifle
RS	–	Rifled shotgun slug
Spec	–	Special
Mag	–	Magnum
Carb	–	Carbine

It would appear that the following is the order of penetration power of the ammunition used in the test series. Further tests to confirm this order should be conducted.

Cal. .22 LR (P) < Cal. .38 < Cal. .22 LR (R) < #4 shot < #00 buckshot < Cal. 357 magnum < 12-gauge rifled slug < Cal. .44 magnum < Cal. .30 carbine SP < Cal. .30 armor piercing (R)

Ballistic Deformation

In addition to the fact that a given round may or may not penetrate a piece of armor, it is important to learn whether the impact of a bullet will cause the armor to deform to such an extent, whether permanently or transitorily, as to cause injury to the wearer. In the tests reported herein, it was found that the ballistic deformation ranged from ¼ inch to 1½ inch, depending on the armor, the caliber of the weapon, and the type of round fired. Should some armor be worn without providing an offset in the form of clothing worn under the armor, an impact, depending on its location, could cause an injury ranging in seriousness from a heavy bruise to a fractured rib or worse. In addition, the effects of hydraulic shock must be taken into account, although quantitative experiments in this field have not been conducted.

To combat the effects of deformation, the U.S. Army has designed a "tension web" which causes rigid armor to stand away from immediate contact with the body, thereby providing the offset mentioned above. In addition, the tension web allows air to circulate behind the armor, thereby reducing the amount of unevaporated sweat and permitting longer wearing of armor under hot, humid conditions.

Brand	Model	Ballistic Material	Bullet Cal.	Type	Number of Hits	Number of Stops
DAVIS	6003-1	Nylon 12 layer	.22 LRHV	L(R)	3	1
			.38 Spec	L	10	10
			.38 Spec	MP	3	1
			12 Gauge	00 Buck	9 Pellets	6
DAVIS	6010-2	Nylon 12 layer	.22 LRHV	L(R)	2	2
			.38 Spec	L	10	10
			.38 Spec	MP	4	1
			12 Gauge	00 Buck	9 Pellets	6
			12 Gauge	#4	1	1
DEFENSOR	V1-A	1 Doron (GRP)	.38 Spec.	MP	10	10
			.357 Mag	L	2	0
			12 Gauge	00 Buck	2	0
			12 Gauge	#4	1	1
FEDERAL-SPOONER	C	Steel	.22 LRHV	L(R)	5	5
			.38 Spec	L, MP	11	11
			.357 Mag	MP	1	0
			12 Gauge	00 Buck	1	0
FEDERAL-SPOONER	708F	Steel	.38 Spec	L, MP	10	10
			.357 Mag	MP	1	0
GOEC	120 (Back)	10 Nylon	.22 LRHV	L(R)	5	2
			12 Gauge	00 Buck	1	0
			12 Gauge	#4	1	1
IMPERIAL	Supershield	Poly-carbonate	.22 LRHV	L(P)	3	3
			.22 LRHV	L(R)	2	0
			.38 Spec	L, MP	11	11
			.357 Mag	MP	1	0
TABOR-Colt		GRP	.22 LRHV	L(R)	3	3
			.38 Spec	MP	10	10
			.357 Mag	MP	1	0
			12 Gauge	00 Buck	9 Pellets	8

Figure 19
BALLISTIC RESISTANCE OF ARMORED VESTS RATED TO RESIST .38 SPECIAL

Brand	Model	Ballistic Material	Bullet Cal.	Type	Number of Hits	Number of Stops
AGRAMONTE	Lancer	Nylon	.22 LRHV	L(P)	3	3
			.22 LRHV	L(R)	5	5
			.38 Spec	L, MP	13	13
			.357 Mag	L, SP	2	0
			.41 Mag	SP	1	0
			12 Gauge	00 Buck	9 Pellets	8
AVCO	PA 100	GRP (11 layer)	.22 LRHV	L(P)	2	2
			.38 Spec	L, MP	11	11
			.357 Mag	L	10 First Shot Penetrated	9
			.357 Mag	L	3	3
DAVIS	6003-3	1 Steel+ 12 Nylon	.357 Mag	L, MP, SP	17	17
			.41 Mag	SP	1	1
			.44 Mag	L	2	2
			.30 Carb	MP	1	0
DAVIS	6007-4	1 Steel+ 12 Nylon	.357 Mag	L, MP, SP	16	16
			.44 Mag	L	4	1
DAVIS	6003-5	3 Steel+ 12 Nylon	.357 Mag	L, MP	2	2
			.44 Mag	L	2	2
			.30 Carb	MP	6	6
			.30 Carb	SP	9	6
			12 Gauge	RS	1	1
DEFENSOR	V2-A	2 Doron (GRP)	.357 Mag	L, MP, SP	16	15
			.30 Carb	MP	1	0
			12 Gauge	00 Buck	1	1
FEDERAL-SPOONER	P	Steel	.357 Mag	L, MP, SP	29	28
			.44 Mag	L	7	6
			.30 Carb	MP	1	0
			12 Gauge	RS	1	0

Figure 20
BALLISTIC RESISTANCE OF ARMORED VESTS RATED TO RESIST .357 MAGNUM

Brand	Model	Ballistic Material	Bullet Cal.	Type	Number of Hits	Number of Stops
GOEC	217 Front	1 Steel+ 10 Nylon	.357 Mag	L, MP SP	10	10
			.30 Carb	MP	1	0
			12 Gauge	RS	1	0
	Back	1 Steel+ 7 Nylon	.357 Mag	L, MP, SP	12	12
GOEC	120 Front	1 Steel+ 10 Nylon	.357 Mag	L, MP, SP	13	13
			12 Gauge	RS	1	0
	Groin	1 Steel+ 10 Nylon	.357 Mag	L	2	2
GOEC	434C	3 Steel+ 10 Nylon	.357 Mag	L, MP, SP	5	5
			.41 Mag	L, SP	2	2
			.44 Mag	L	2	2
			12 Gauge	RS	1	1
			.30 Carb	MP	3	3
			.30 Carb	SP	4	3
ROLLS ROYCE-Colt	Security	GRP	.357 Mag	L, MP, SP	13	13
			.44 Mag	L	4	3
			.30 Carb	MP	1	0
			12 Gauge	RS	1	0
SKYLINE	SK 426328	GRP	.357 Mag	L	1	1
			.44 Mag	L	10	10
			12 Gauge	RS	1	1
TRANSCON	401V	2 Doron (GRP)	.357 Mag	L	10	9
			.357 Mag	MP, SP	3	3
			.30 Carb	MP	1	0
			12 Gauge	00 Buck	1	1

Figure 20 (Continued)
BALLISTIC RESISTANCE OF ARMORED VESTS RATED TO RESIST .357 MAGNUM

Brand	Model	Ballistic Material	Bullet Cal.	Type	Number of Hits	Number of Stops
AVCO	PA 500	$Al_2 O_3$+	.30(R)	APM2	3 Front	3
		GRP	.30(R)	APM2	3 Back	0*
CARBORUNDUM	KT-1	Doron (GRP) & Ceramic	.30(R)	APM2	1 Groin	0
			.30(R)	APM2	4 Front (#4 Failed)	3
			.30(R)	APM2	1 Coccyx	1
			.30(R)	APM2	4 Back (#3 & 4 Failed)	2

Figure 21
BALLISTIC RESISTANCE OF ARMORED VESTS RATED TO RESIST .30 AP

*Special note on Ceramic Armor Testing. Two makes of ceramic armor were employed in the tests reported herein, AVCO PA 500 and Carborundum KT-1 Armor. Both brands proved less than satisfactory on initial testing, AVCO PA 500 failing in the back section, where none of three caliber .30 armor piercing rounds were stopped and Carborundum KT-1 Armor in the groin section where an initial caliber .30 armor piercing round penetrated.

In the instance of AVCO PA 500 Armor, a claim was made by the manufacturer, after examination of the armor subsequent to firing, that the armor had been dropped, or otherwise mishandled prior to the test, so that first round impermability was not maintained; consequently, the manufacturer asked for a retest of PA 500 armor at his plant at Lowell, Massachusetts. Armor was randomly selected from the AVCO production line and subjected to caliber .30 firing on the AVCO range. The retest proved satisfactory, with the PA 500 unit stopping three of three caliber .30 armor piercing rounds fired at 2850 feet per second.

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- *Protective Helmets*
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POLICE WEAPONS CENTER

BOMB TRANSPORT VEHICLES

CHARLES S. STEVENSON

REPORT SERIES 6-70

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11 FIRSTFIELD ROAD • GAITHERSBURG, MARYLAND 20760 • AREA CODE 301—TEL. 948-0922

CONTENTS

BOMB TRANSPORT VEHICLES

INTRODUCTION

One of the problems confronting public safety agencies in dealing with increased bombing activity throughout the nation is that of transporting a bomb or suspected bomb from the location where it is found to an area where it can be destroyed or dismantled. Transportation of the bomb to a disposal area generally means that it must be moved by surface vehicle through public areas to reach its destination. In many cases, this involves the transportation of potentially dangerous devices along streets in crowded urban centers where detonation would predictably result in the injury or death of innocent persons.

In times past, when bombing was a rare phenomenon confined to several of our larger cities, there was little widespread public safety interest in the problems posed by bomb transporting. In the absence of standardized doctrine, bomb transport vehicles were designed independently by those public safety agencies that experienced a sufficiently high level of bomb activity to justify the construction of a special purpose vehicle.

The purpose of this publication is to briefly examine the nature of the bomb transport problem and to describe the vehicles that have been constructed by various public safety agencies in response to this challenge.

THE BOMB TRANSPORT PROBLEM

In order to understand the nature of the bomb transport problem, it is necessary to know the characteristics of an explosion or detonation. For the purpose of illustration, consider the transport problems created by a typical pipe bomb.

EXPLOSIVE EFFECTS

A pipe bomb consists of a section of explosive-filled metal pipe having both end caps screwed in place. When the pipe bomb, or any explosive, is detonated, the chemical explosive material is instantaneously converted from a solid into a rapidly expanding mass of gases. The detonation of the explosive will produce three primary effects and several associated secondary effects which can cause great damage to the area surrounding the explosion. The three primary effects produced are fragmentation, blast pressure, and incendiary or thermal effects as illustrated in figure 1.

Fragmentation

When detonation takes place, the pipe is literally stretched and expanded to about one and one-half times its original diameter before it tears and breaks into fragments. About half the total

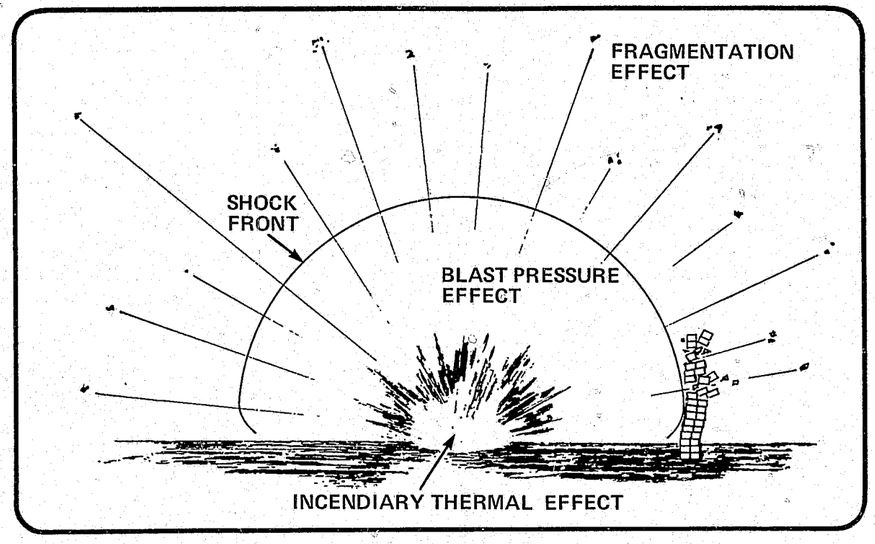


Figure 1
EFFECTS OF AN EXPLOSION

energy of the explosive is expended in this rupturing process and in propelling the fragments outward. The size of the fragments produced depends both on the nature of the explosive and the type of metal involved. The use of a *high* explosive in a pipe bomb results in thinner and smaller fragments, while fragments from a pipe bomb containing a *low* explosive, as illustrated in figure 2, are usually larger, with occasional intact chunks of pipe being found. Some pipe bomb fragments may attain a velocity of 2,700 feet per second, comparable to that of a military rifle bullet, while others travel much slower, depending upon the amount and type of explosive. Regardless of size and speed, fragments travel in a straight line of flight until they lose their velocity and fall to earth, or strike some object and either ricochet or become embedded in the material they strike. Obviously, fragments in flight represent a hazard to both personnel and property.

Blast Pressure

One of the effects created by the blast pressure from the detonation of a bomb is the *shock front,* which is a thin layer of compressed air on the leading edge of the *positive pressure wave.* The shock front imparts a sudden, hammering blow to objects in its outward path. The blast pressure wave may travel at a speed of up to 7,000 miles per hour as the gases generated by the detonation expand from 10,000 to 15,000 times the original volume of the explosive. The outward movement of the positive pressure wave, figure 3, with its accompanying shock front, creates a *partial vacuum* near the point of detonation. As a result, when the positive pressure wave is reduced in strength and finally loses its power, a reverse movement of air inward, towards the point of detonation, occurs. This creates the *negative or suction phase*, illustrated in figure 4, which although not as powerful as

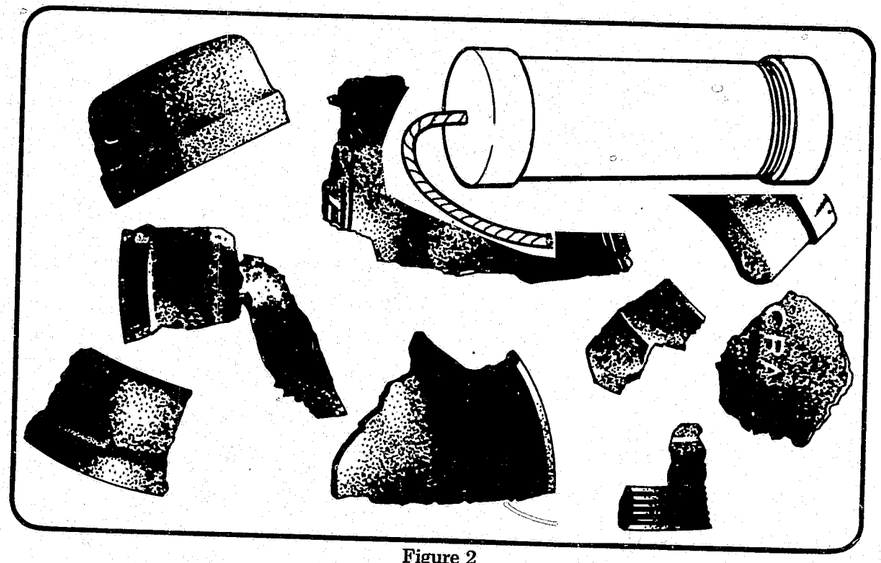


Figure 2
LOW EXPLOSIVE PIPE BOMB AND TYPICAL FRAGMENTS

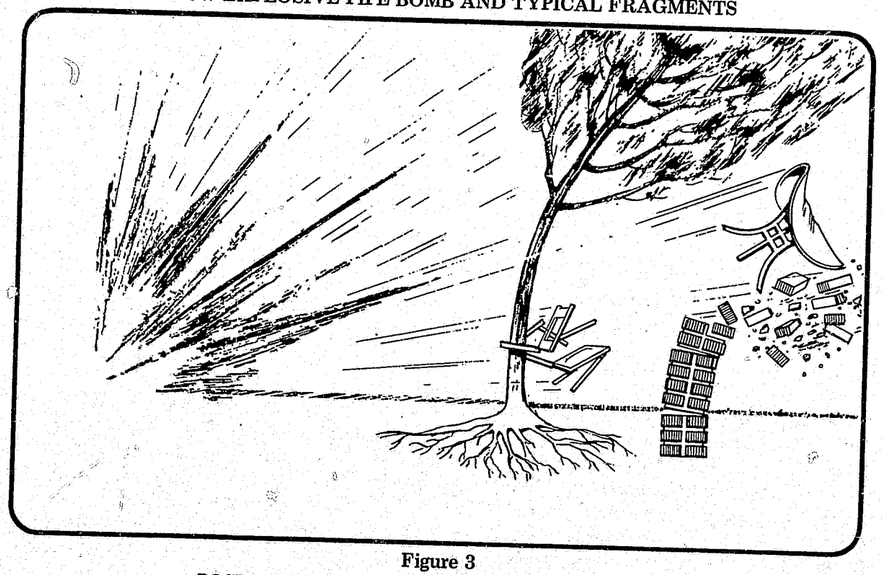


Figure 3
POSITIVE PRESSURE PHASE OF AN EXPLOSION

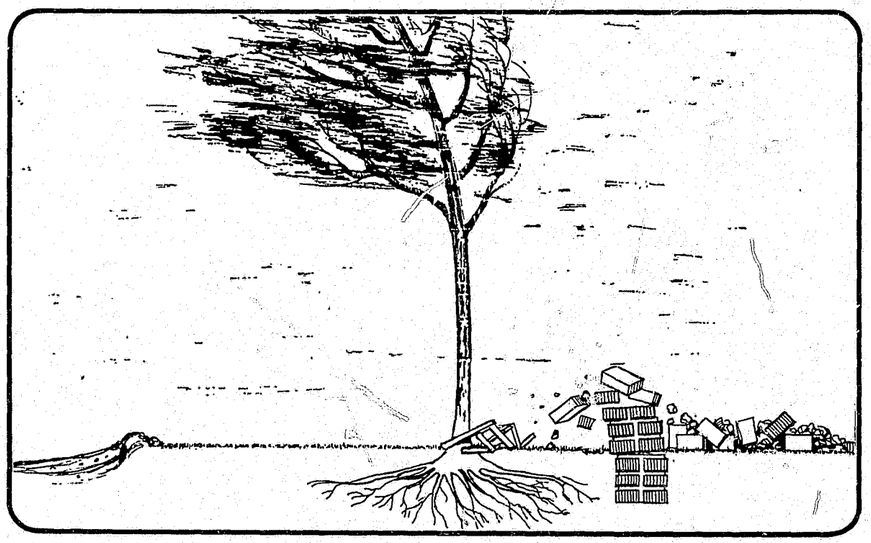


Figure 4
NEGATIVE PRESSURE PHASE OF AN EXPLOSION

the positive phase, lasts about three times as long. Thus, blast pressure actually delivers a "one-two" punch to objects in its path.

Another characteristic of blast pressure waves is that, like sound or light waves, they may be reflected from surfaces. When the blast pressure wave is reflected or bounced off an intervening surface, the wave may either be weakened by scattering or diffusion or intensified by a focusing action. If detonation occurs inside a building or container, the pressure wave is usually intensified at certain points as a result of reflection from confining surfaces.

Thermal Effects

The incendiary or *thermal effects* produced by a detonation vary for different explosives. The effect is seen as a bright flash and is measured in fractions of a second. In general, high explosives produce greater heat for a shorter period of time and low explosives generate lower but longer lasting heat. Unless highly combustible materials are involved, the thermal effect is not a significant hazard in connection with detonations. While the debris resulting from a detonation may provide an additional source of combustible material, the risk of fire in most bombing incidents is not as great as commonly believed. In terms of containment and transport, the thermal effect of explosive devices is of concern only in those instances where fiberglass baskets or containers are employed.

Secondary Effects

In addition to those effects which are directly produced by the detonation of an explosive, there are some *secondary effects* which may also result. For example, a possible secondary effect would be the transmission of the shock wave through earth or water, or through load-bearing walls or the columns of buildings. Another secondary effect is fire, which can result from shorted electrical circuits or ruptured fuel lines and be fed by debris caused by the detonation.

Both the primary and secondary effects of an explosion are produced whether the detonation results from a pipe bomb or some other form of explosive device. Naturally, there are differences in the magnitude of the effects produced, depending upon the materials used in the construction of the bomb. For example, unconfined dynamite, illustrated in figure 5, would produce less fragmentation and greater blast pressure than would a pipe bomb. On the other hand, fragmentation could be increased by attaching metal particles to the dynamite, as shown in figure 6, or by confining the dynamite in a metal container. In any event, it must be anticipated that the detonation of an explosive device will produce some degree of fragmentation, blast pressure, and heat.

CONTROLLING EXPLOSIVE EFFECTS

When a bomb or suspected bomb has to be transported from the scene of an incident to a safer area, the device should be placed in some sort of container which will minimize the effects of blast

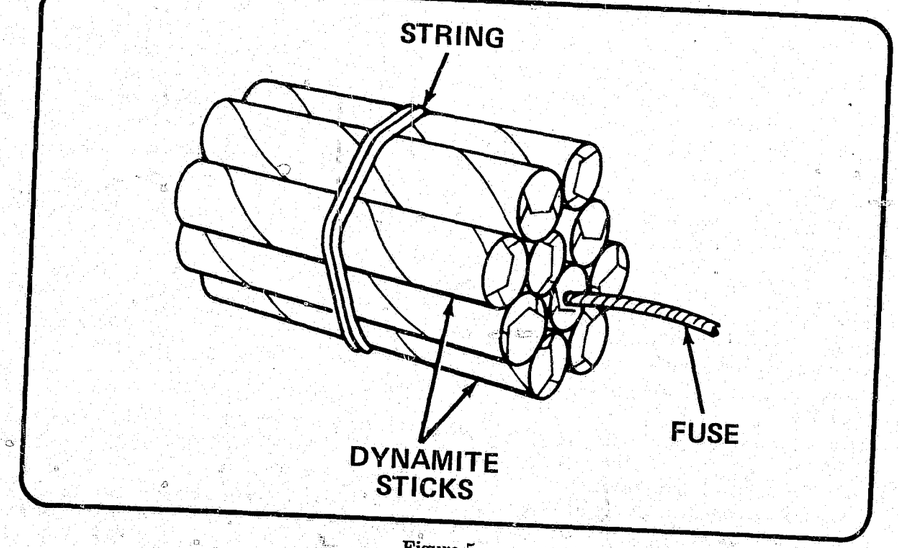


Figure 5
UNCONFINED DYNAMITE BOMB

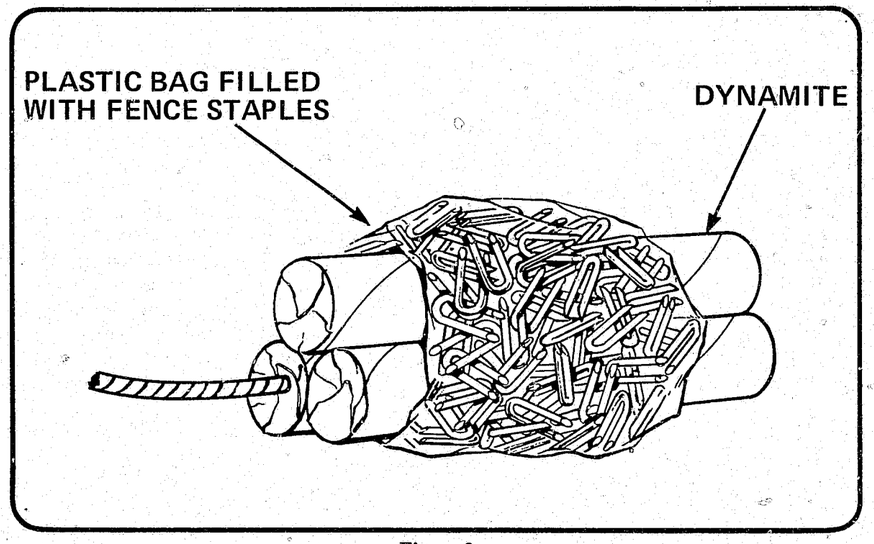


Figure 6
FRAGMENTATION ADDED TO DYNAMITE BOMB

pressure, fragmentation, and heat, as well as reduce any secondary blast pressure effects. It would be ideal to completely contain all the blast pressure, fragmentation, and heat resulting from the detonation of any type of bomb. Unfortunately, it is neither possible nor practical to construct such a container, since its size, weight, and cost would be prohibitive. Consequently, what is generally attempted is the reduction or control of the explosive effects rather than complete containment.

Blast pressure may be controlled by diffusing the blast pressure wave, thus causing it to dissipate in force as it travels outward, or by causing the wave to be deflected in a way that will avoid intensification through the focusing effect described previously. Similarly, fragmentation may be controlled by deflecting the paths of the fragments and/or by attempting to slow down or capture the fragments in some kind of material. The effects of the heat generated by a detonation can generally be safely ignored if only noncombustible material is selected for the construction of the bomb container and its accessories.

In the design of bomb containers, the term *nondirectional* is used to describe those units which attempt total containment of fragmentation and total or partial containment of blast pressure. On the other hand, containers that attempt to vent or direct fragmentation and blast pressure are referred to as *directional* units. Obviously, the nondirectional container would have to be larger and heavier because of the large volume of gases and the total fragmentation to be contained. However, this weight and size may have to be accepted if the container is intended for use in high-rise and heavily populated areas where the risk of releasing any significant blast pressure and fragmentation

would not be acceptable. Directional containers are smaller and lighter and are usually mounted vertically. The blast pressure and fragmentation are vented either upward or both upward and downward depending upon whether the container has a closed bottom or has been left open at both ends.

Thus, both nondirectional and directional containers are designed to deflect and/or entrap the fragmentation and to control the venting of the blast pressure wave.[1] They may additionally be equipped with accessory fragmentation blankets or shields which, when placed over openings or vents, further confine or reduce the velocity of the fragments. Reduction or elimination of the secondary blast pressure effects is attempted through mounting the container in sand or other super-absorbent material, and through the suspension system and tires of the vehicle on which the container is mounted.

HANDLING AND MOBILITY

The nature of the bomb transport problem involves more than merely a consideration of the bomb container itself. Ideally, there should be some means, either designed as part of the bomb transporter or improvised, to lower the bomb into the bomb container remotely and to safely remove it from the bomb container after arrival at a safe area.

Another important factor in the bomb transport problem is the vehicle itself. Without considering tracked vehicles, which are not believed to be practical in this role, there are three types of vehicles that can be utilized to provide mobility for bomb containers:

- *Semitrailer.* Depending upon its size and construction, a semitrailer can support great weight and bulk, but has the disadvantage of having to be pulled by a truck-tractor, the absence of which, when needed, may delay response time.

- *Trailer.* The full or towed trailer, depending upon size, has the advantage over the semitrailer of being towable by a wide range of general purpose trucks or cars. Like the semitrailer, it must be tested for roadability and maneuverability to assure that it is functional for the jurisdiction in which it is to be used.

- *Truck.* With truck units, the bomb container is either mounted on the normal truck bed or on a specially reinforced structure mounted on the chassis. Truck-mounted bomb containers have the advantage of great mobility, depending upon the size and capacity of the truck. They have the disadvantage that if the truck is not serviced and driven regularly, it may not start or operate properly, thus putting both the container and transporter out of operation when needed.

In many instances, the cost of designing, testing, and manufacturing a suitable bomb transport vehicle may be prohibitive. In fact, some of the more desirable and even necessary features of a bomb transporter may have to be sacrificed if cost is the overriding factor in its construction or

[1] Even nondirectional containers currently in use do not attempt to fully contain the blast pressure wave, but generally attempt to diffuse or break up the full force of the wave.

procurement. What is needed is a safe and functional bomb container and an efficient bomb transporter at a reasonable cost.

ACQUIRING A BOMB TRANSPORT VEHICLE

Caught between the conflicting values of full protection and budget limitations, the public safety official must reach some compromise regarding the acquisition of bomb transport capability. While decisions of this kind can only be made on the basis of local conditions, several points should be considered.

- *Need.* The actual or potential need for a bomb transport vehicle can only be based upon local bomb experience and the availability of outside bomb incident support. If a nearby public safety agency is willing to share a transport vehicle, it may be difficult to justify the procurement of a special-purpose vehicle even when the level of bomb activity suggests that a need exists.

- *Protection.* Perhaps the greatest single factor affecting the cost of a bomb transport unit is the level of protection desired. Since it is generally agreed that the current state of the art in explosive containment precludes the design of a practical mobil unit that will meet the threat of any size bomb, some decision must be made regarding the level of protection that will be acceptable.

As a purely practical matter, the amount of explosive in a homemade bomb would probably not exceed the weight that could be carried to the target by a single person. Consequently, the outer practical limit of desirable protection would appear to be about a case, or 50 pounds, of 60 percent dynamite. While this level of protection may not always be achievable within cost parameters, it is technically feasible and at least furnishes a point of reference.

Evaluation and rating of a bomb transport vehicle should be carried out whether the unit is locally constructed or purchased. The explosive rating should be based upon the weight of explosive, 60 percent dynamite for example, that can be detonated repeatedly in the unit without causing permanent deformation of the container. Qualitative-type blast gauges should be located around the unit during evaluation to monitor the blast wave from the detonations to determine the degree of danger to users in the event of an unplanned explosion as well as to assist in establishing safe working distances and zones around the unit.

It is also essential in the rating of a bomb container and vehicle that the container and vehicle be evaluated as a complete unit, as both are subjected to blast pressures during detonation of bombs or explosive devices. The container is directly exposed to the rapidly expanding gas from the explosion and possibly the fragments, and the trailer is subjected to a downward reactive thrust equal to the upward thrust of the blast.

- *Cost.* The total cost of a bomb transport vehicle is largely established by the size, containment capacity, and material of the container as well as the type and size of the truck or trailer required to transport the container from the location of a bomb or explosive device to a designated safe area. Labor costs must also be absorbed if the unit is constructed locally by

public or private enterprise. Because of their high cost and infrequent use, a bomb transport vehicle is a poor investment for most communities. In urban areas, regionalization or sharing of a bomb transport vehicle can result in considerable savings to individual agencies. In those jurisdictions where bombing activity is rare, a transporter can be improvised from such materials as aircraft tires and sandbags.

However, local fabrication of steel containers should be attempted only if expert advice and craftsmanship are available. For example, the material selected for the construction of the container should be based upon the following considerations: toughness as defined by the Charpy V-notch impact values and the Nil Ductility Temperature as defined by the Naval Research Laboratory, weldability, availability, cost, heat treatment, and yield strength. The steel to be selected should be ASTM grade A537A pressure-vessel steel in the normalized condition. This steel, when properly welded, exhibits high levels of strength and toughness at the range of ambient temperatures normally encountered throughout the United States.

- *Implementation.* Finally, it should be recognized that the bomb transport vehicle is only one component of what should be a total system for the handling of suspicious devices or bombs. Trained personnel must be available to remove the actual or suspected bomb from a building and to disarm or destroy the device once it has been moved to a safe area. Without effective procedures and skilled personnel, the bomb transport vehicle will make little contribution to the quality of public safety response to bomb incidents.

TYPICAL BOMB TRANSPORT UNITS

This section will describe a number of bomb transport vehicles currently in use in the United States and Canada. There are three types of vehicles for the transportation of potentially dangerous devices: nondirectional containers, directional containers with single venting, and directional containers with double venting.

NONDIRECTIONAL CONTAINERS

New York City

The first specifically designed bomb transporter was fabricated by the New York City Police Department's bomb squad in 1941. The bomb container consists of two concentric cylinders of woven 5/8-inch steel cable, with a 10-inch air space between the inner and outer cylinders. The inner cylinder is 9 feet 4 inches in length and 5 feet 8 inches in diameter. A steel door hinged at the center permits access to the inner cage. As illustrated in figure 7, both cylinders are supported by a steel frame extending through, around, and on both ends of the container. The overall weight of the bomb container is 18,000 pounds.

The 7 ½-foot-wide highboy semitrailer on which the New York City bomb container was originally mounted weighed 7,000 pounds, making the overall unloaded weight of the original trailer and container about 25,000 pounds. This original transporter is shown in figure 8.

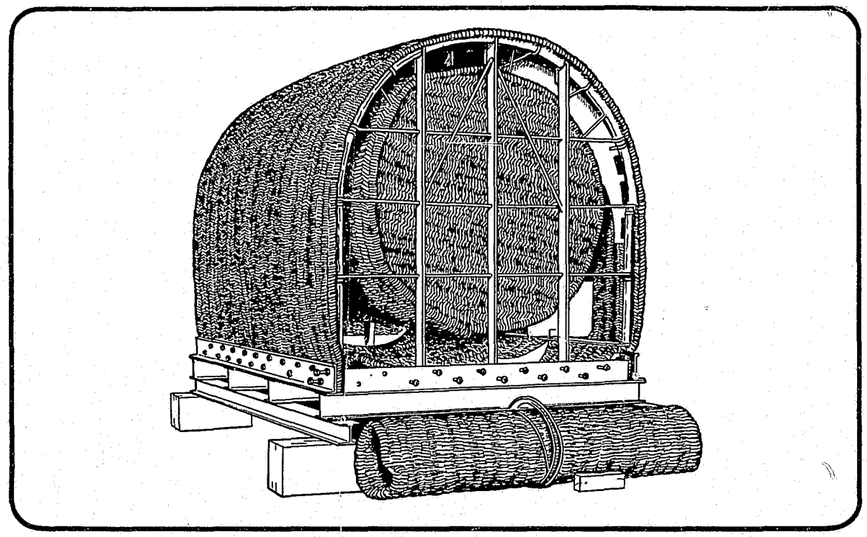


Figure 7

INTERNAL CONSTRUCTION OF NEW YORK CITY BOMB CONTAINER

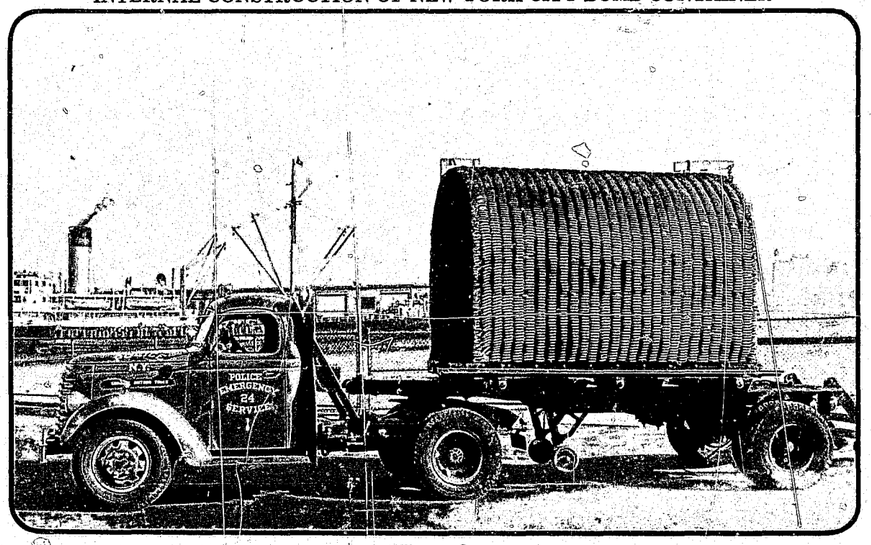


Figure 8

ORIGINAL NEW YORK CITY BOMB TRANSPORT VEHICLE

In 1965, the container was removed intact from the original highboy semitrailer and remounted on a lowboy semitrailer, with overall weight and width remaining approximately the same. The current New York bomb transporter is shown in figures 9 and 10.

The nondirectional principle was selected by New York City because it was felt that the blast pressure and fragmentation believed associated with a directional-type bomb container would pose a danger to upper floors of the tall buildings common to New York City. The New York bomb container is designed so that fragmentation will be fully retained within the bomb container, while the blast pressure will be scattered by passing through the interstices of the woven 5/8-inch steel cable netting of the inner and outer cylinders of the container. Although there have been no instances reported where the bomb transporter has had to withstand the detonation of an actual bomb, it has repeatedly withstood test detonations of up to 25 sticks of 40 percent dynamite.

The advantages of a bomb container of this type of construction are that, with fragmentation designed to be contained, there is little or no fragmentation hazard to citizens or public safety personnel and that, with the blast pressures being dissipated and scattered, there is minimal danger to nearby structures. The secondary blast pressure effects are also minimized through the use of this design. The disadvantages of the New York City design are that the weight and size of the container necessitate the use of a suitably large truck-tractor which may pose problems in moving through crowded city streets and alleys. Also, the required use of a truck-tractor may create a response problem if it is not available at all times, or on reasonably short call. The availability of a trained tractor-trailer operator may also be a limiting factor in timely response.

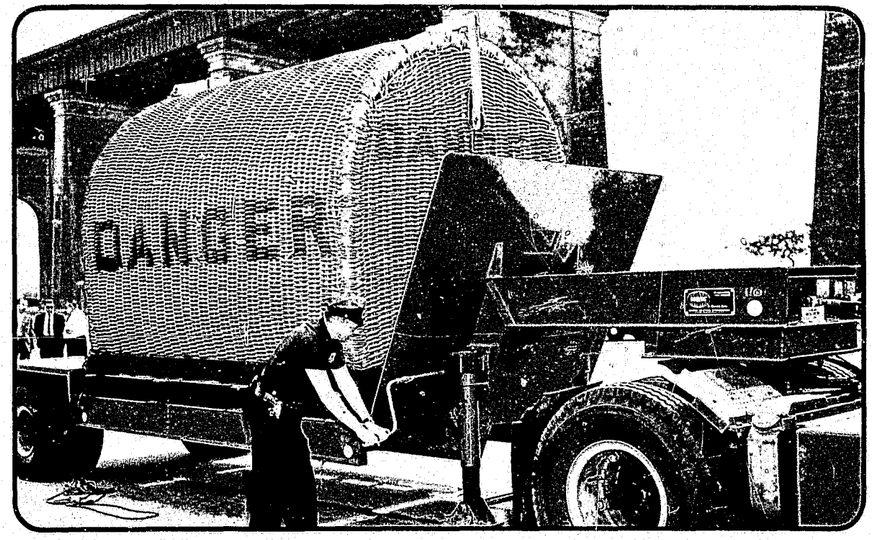


Figure 9

CURRENT NEW YORK CITY BOMB TRANSPORT VEHICLE

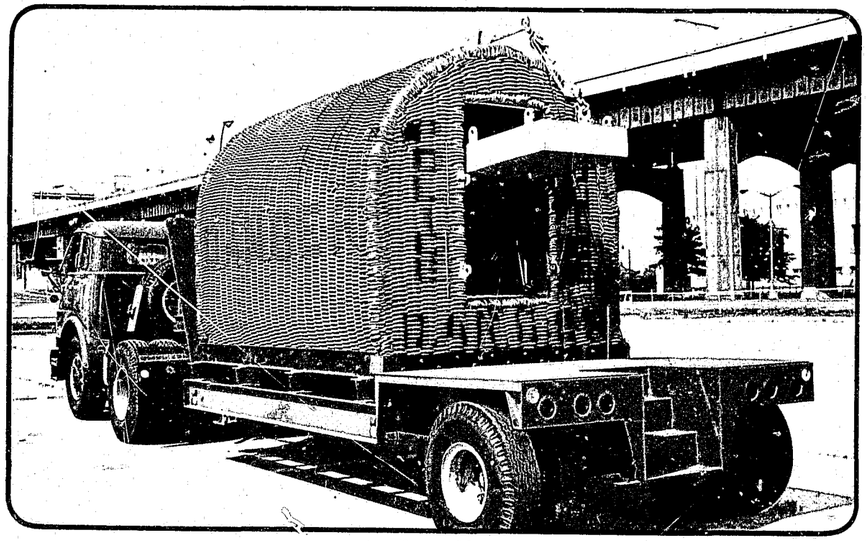


Figure 10
CURRENT NEW YORK CITY BOMB TRANSPORT VEHICLE

Since the New York bomb transporter is used in conjunction with a mobile unit which carries all the necessary handling, detection, identification, and protective equipment, there are no provisions or requirements for accessory equipment storage on the bomb transport vehicle.

DIRECTIONAL CONTAINERS, SINGLE VENTING

Nassau County, New York, Truck

The bomb transport truck currently in use by the Nassau County Police Department was constructed in 1962. The container, which is shown mounted on the truck in figure 11, is made of 1-inch homogeneous armor plate welded into a cylinder that is 3 feet 6 inches in diameter and 4 feet 6 inches high. The bottom section of the container is closed and has a rounded base which rests in a 1-foot bed of dry sand. Another foot of dry sand is placed at the bottom of the container. The bomb container itself weighs 1,800 pounds and has three lifting rings welded to the sides at the open end. These rings are used for removal and replacement of the bomb container during maintenance, and to hold it securely to the truck bed.

The truck has a 194-inch wheelbase, Ford F 600 chassis with specially-designed, externally accessible compartments at the level of the truck bed. A ½-inch steel deflector plate was installed on the rear of the cab, angled at 45 degrees to the truckbed and extended over the top of the cab to

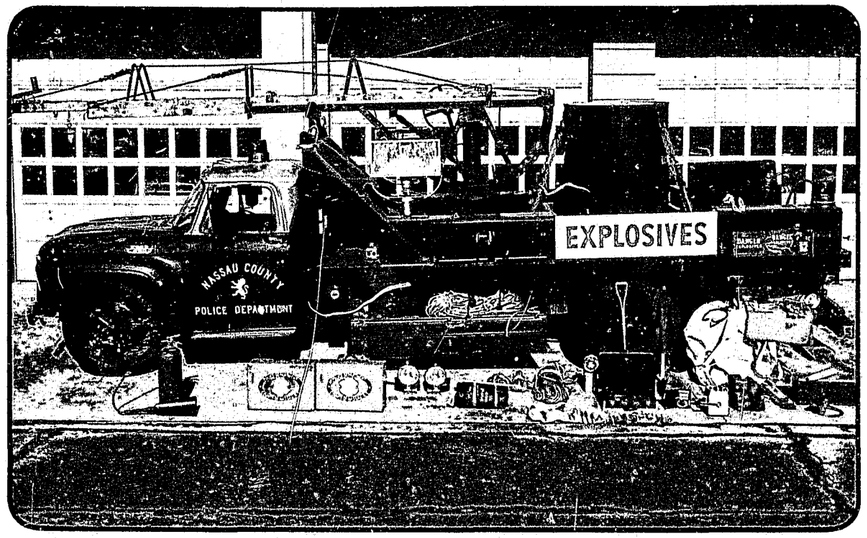


Figure 11
CURRENT NASSAU COUNTY BOMB TRANSPORT VEHICLE

protect crew members. Additional equipment storage compartments are found under this deflector plate. Other features of this bomb transporter are shown in figure 12.

The directional upward venting of the bomb container was selected by Nassau County because the area is largely suburban in nature, with relatively few of the tall buildings found in a highly urban area. Thus, the reflected and direct blast pressure and fragmentation were not seen as posing unacceptable risks. In fact, when in one test the bomb transporter was parked in front of a 19-story building and an explosive was detonated in the bomb container, no blast pressure or fragmentation damage occurred to any of the floors. The Nassau County bomb container has withstood the detonation of up to 40 sticks of 40 percent dynamite in test firings. Magnaflux tests of the bomb container after the detonation confirmed that no damage or deformation had occurred to the container itself nor was there any damage to the transporter.

An advantage of a bomb container of the Nassau County type is that blast pressures are vented and controlled directionally and, with use of a bomb blanket over the top to reduce the velocity and to trap fragments, the hazards of fragmentation are materially reduced. Although it is advantageous to have a wide variety of tools and equipment included in the handy compartments on the bomb transporter, mechanical failure of the truck would deny use of both the bomb carrier and the equipment. Despite this possible disadvantage, this bomb transporter is a well-designed and practical vehicle.

NASSAU COUNTY BOMB TRUCK SUPPLEMENTARY DATA

Truck Body	
16' Flat Bed	1/8" diamond plate steel deck, ½" thick smooth steel plate on deck under the bomb container.
Special Features	
Generator	5,000 w. Onan Electric Start, 230 v. single phase, located under steel deflector plate.
Liquid Holding Tank	24 x 30 x 30", with bottom drain valve for flushing, located at rear of truck.
Ladder	Hydraulic, 30' turret-type. Accessory light mounts at top of ladder.
Bomb Container Cover	42" aluminum rain cover. Never used when carrying explosives.
Special Equipment	
Davis Acousti-Sensor	Sound detector for time mechanisms in bombs.
Rigid Pipe Wrenches	6" to 36"
Nylon Rope	1,000'
Davis Bomb Blanket	4 x 4'
Set of Sound-Powered Telephones	With wire
Emergency Lights	Battery and quartz-type mercury vapor lamps.
Mercury Vapor Lamps	Two, 4,000 w.
Portable Fluoroscopy Shield	
X-ray Cassette	
Portable Bucky X-ray Unit	
Nitro-Neutralizer Kit	
Excavating Tools	
Protective Clothing	
Military-Type Mine Detector	
Assorted Hand and Power Tools	

Figure 12

Dade County, Florida, Truck

The bomb container on the Dade County truck was constructed in 1962 and is made of 3/4-inch cold rolled steel, triple welded to form a cylinder 3 feet 6 inches wide and 4 feet 6 inches deep. A 3/4-inch spun steel rounded boiler head is welded to the bottom. The bottom of the bomb container is filled with one foot of dry sand and the container itself is embedded in two feet of dry sand to a depth of one foot. A drawing of the unit appears in figure 13.

The truck, shown in figure 14, is a standard, 2-ton, 1962 heavy-duty International with a long chassis and heavy-duty springs. A deflecting plate of ½-inch steel is located on the front of the truck bed at a 45-degree angle, with the top extending over the top of the cab for crew protection. Ten-gauge steel was used in the fabrication of sides for the truck bed, and compartments are included for storage of minimum amounts of equipment.

The Dade County bomb container has never been subjected to an operational detonation, but has been successfully tested using 24 sticks of 40 percent dynamite with no resulting damage or deformation of the bomb container or transporter. The advantages and disadvantages of this bomb transporter are similar to those mentioned in connection with the Nassau County bomb transporter.

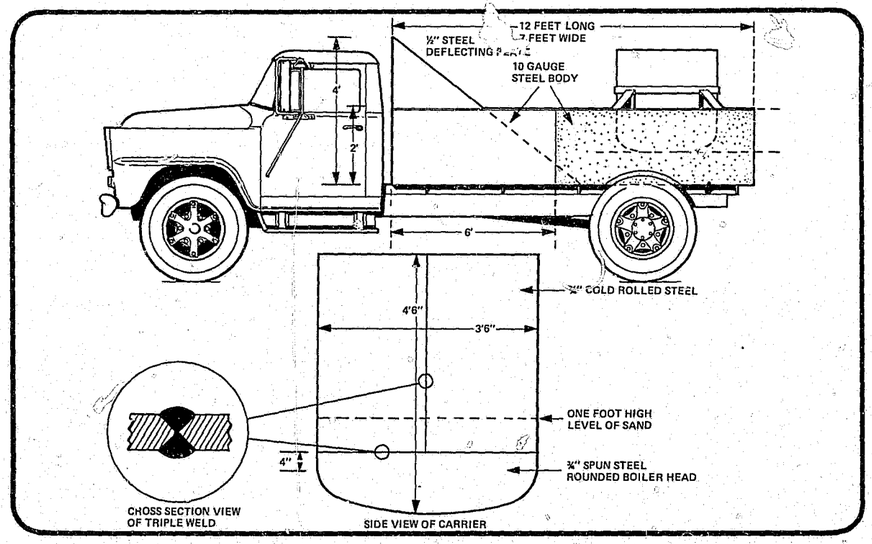


Figure 13
DRAWING OF DADE COUNTY BOMB TRUCK

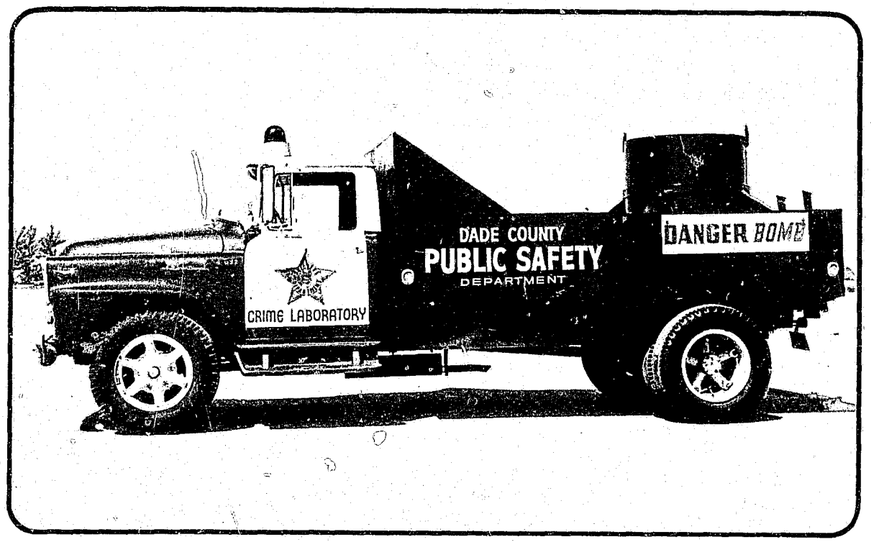


Figure 14
DADE COUNTY BOMB TRUCK

Toronto, Canada, Truck

The bomb container used by the Toronto Police Department was built in 1962 and put into use in 1963. It is made of 3/4-inch cold rolled steel and is 3 feet 6 inches in diameter and 4 feet deep. Sand is placed in the bottom of the container. The Toronto bomb container is presently mounted on a truck as a carrier vehicle, but the users believe that a trailer mounting would be preferable. The Toronto bomb transporter is shown in figure 15. The Toronto container has been tested successfully using up to 29 sticks of 40 percent dynamite. The advantages associated with other bomb transporters having a truck as a carrier apply to this unit. A disadvantage may lie in the comparatively shallow depth of the bomb container.

Columbus, Ohio, Trailer

The bomb trailer in use by the Columbus Fire Department, shown in figures 16 and 17, was built in 1965 with the bomb container as an integral part of the bomb transporter. It has an angle-sided box constructed of ¼-inch steel plate with inside dimensions of 4 feet by 3 feet at the top and approximately 3 feet by 2 feet at the bottom. The inner walls incline inward 10 degrees from top to bottom. The walls and bottom are of double wall construction, 3 inches apart and filled with dry silicone sand. One foot of dry sand or several sandbags cover the bottom of the bomb container.

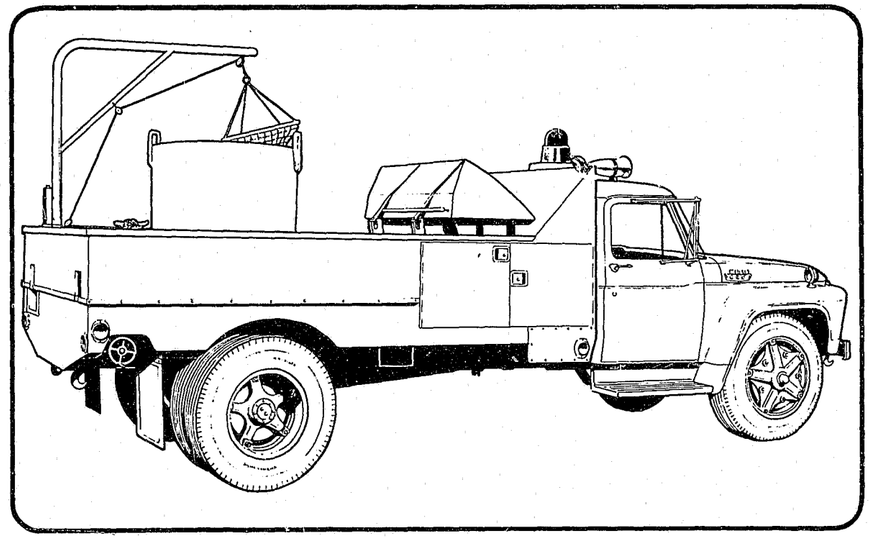


Figure 15
TORONTO BOMB CONTAINER AND TRUCK

A danger of the Columbus design, that of sharp inner corners, has been recognized and is being corrected by the inclusion of a welded steel plate at 45-degree angles to each corner and lapped some distance in both directions along the side plates. Sharp corners are a disadvantage because such angles tend to intensify the blast pressure waves, but the addition of the angle plates will break up the corner wave reflection pattern.

The trailer can be towed by any light truck or passenger car with standard ball and socket towing equipment at speeds up to 85 m.p.h. Although the Columbus bomb vehicle has never suffered an operational detonation, it has been tested and has satisfactorily withstood the detonation of 10 sticks of 40 percent dynamite. This unit has the advantage of being extremely mobile and provides great flexibility since it can be towed by several types of common vehicles. A disadvantage might be its comparatively light construction, should a known or suspected bomb of a size larger than 10 pounds detonate in the transporter. A second disadvantage is the 10-degree angle of the sides which permits a larger direct fragment escape area than would be found in a vertical-sided container.

Colt Bomb Transport Trailer

Colt Industries, 150 Huyshope Ave., Hartford, Conn. 06102, has acquired rights to market a bomb transport trailer formerly designed and made by Criminalistics, Inc., of P.O. Box 363, Opa-Locka, Florida 33054. This unit, formerly called the Suspicious Item Disposal (SID) trailer and now called

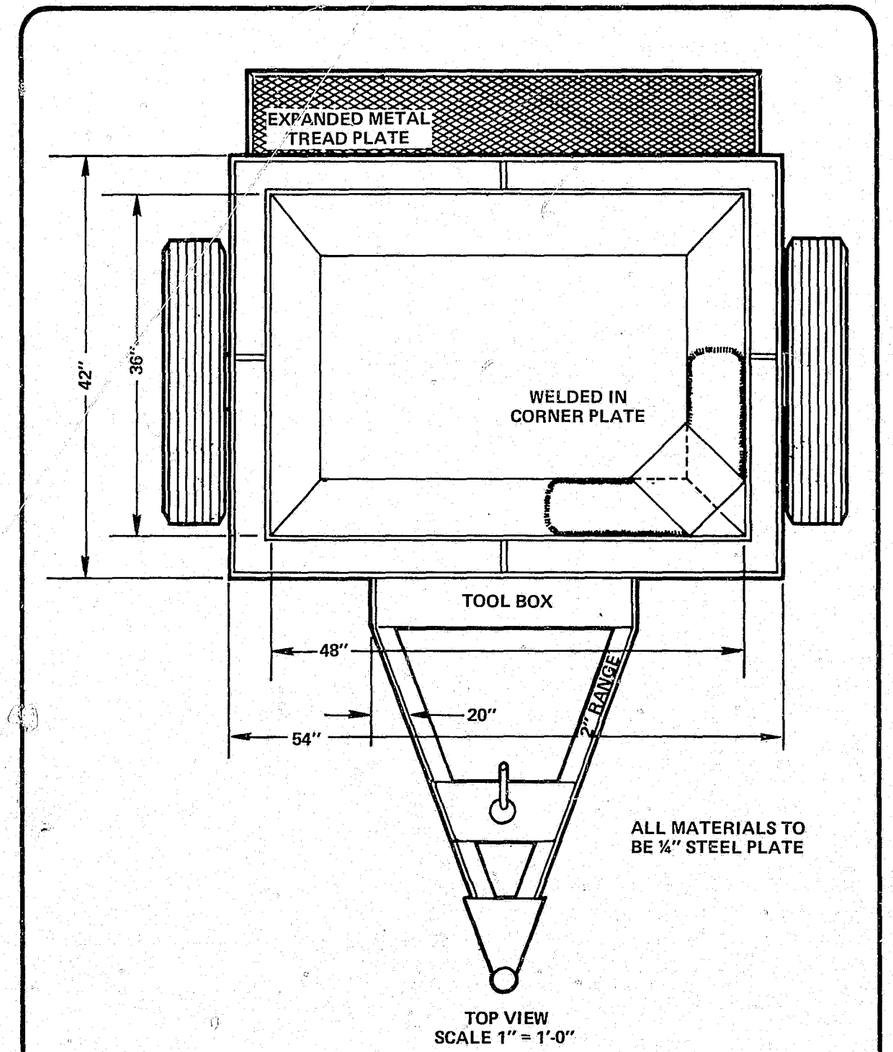


Figure 16
DRAWING OF THE COLUMBUS BOMB TRAILER

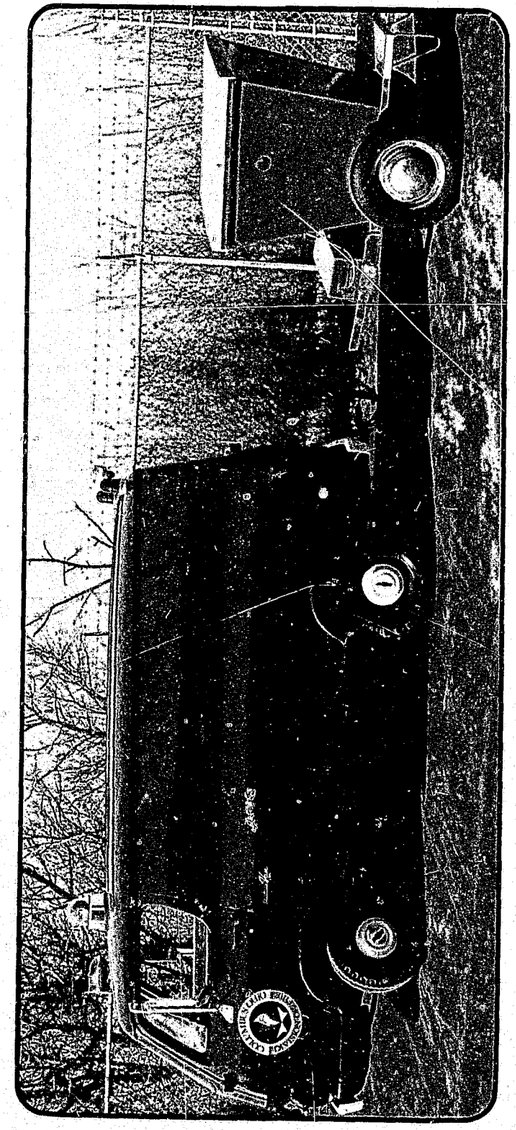


Figure 17
COLUMBUS BOMB TRAILER ATTACHED TO BOMB UNIT TRUCK

the Colt Bomb Transport Trailer, is manufactured in two models. One model is shown in figures 18 and 19. The other is similar, but does not have the equipment cabinets. The former costs $7,500 and the latter $5,500, both FOB Miami. A 30-day delivery time is quoted by Colt for these items.

The bomb container of this unit is double-walled, with an inner, 3-foot diameter cylinder of 1-inch mild steel that is 3 feet 8 inches deep. The outer cylinder is of ½-inch mild steel with a diameter of 4 feet. The 6-inch space between the walls is filled with dry sand. The bottom of the container is similarly double-walled with curved contoured bases in both the inner and outer cylinders. Additionally, one foot of dry sand is carried in the bottom of the entire bomb container. The container is compatible with the Colt-Tabor Bomb Basket Handling System which fits inside the trailer cylinder. The trailer including sand weighs 7,500 pounds. The unit is marketed with several styles of camouflage for less conspicuous movement through public areas. It can be towed at speeds up to 60 m.p.h. behind a standard squad car with standard ball and socket towing equipment.

This bomb container has been tested with 33 sticks of 60 percent dynamite, which produced slight distortion or deformation of the bomb container and damaged two earlier models of the axle. It has not been tested in close proximity to tall buildings to determine the damage caused by blast pressure and fragmentation at higher elevations. The advantages of this unit, aside from those accruing to all bomb containers that are trailer-mounted, are that it is a compact unit, is commercially available, and has a substantial double-wall construction.

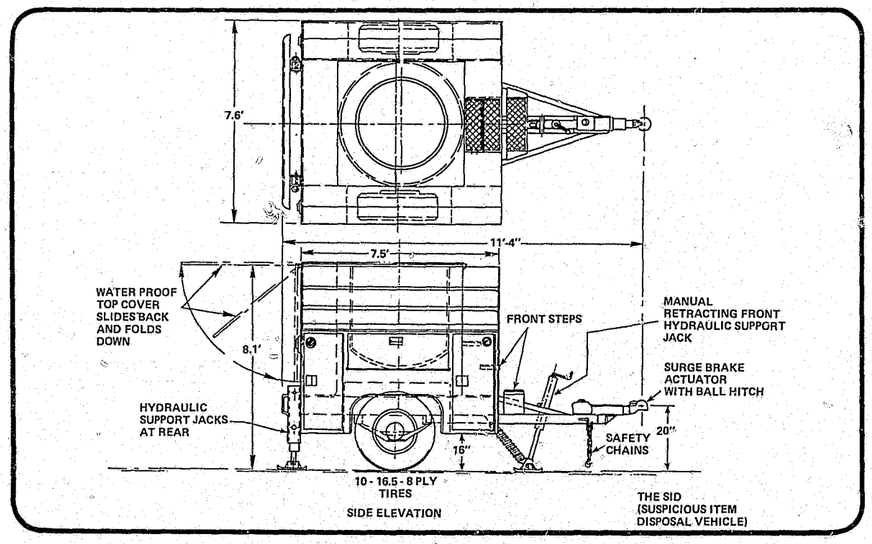


Figure 18
DRAWING OF THE COLT BOMB TRANSPORT TRAILER

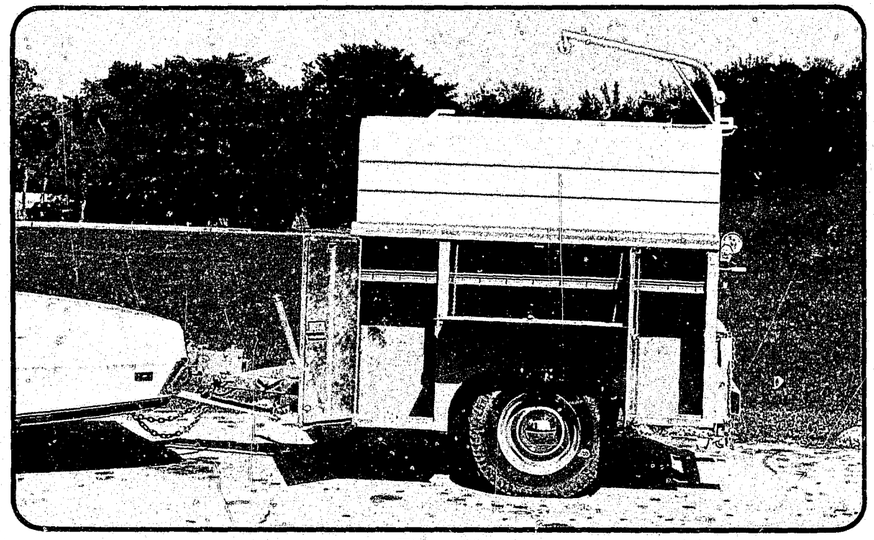


Figure 19
THE COLT TRAILER WITH ACCESSORY AND EQUIPMENT COMPARTMENTS OPEN

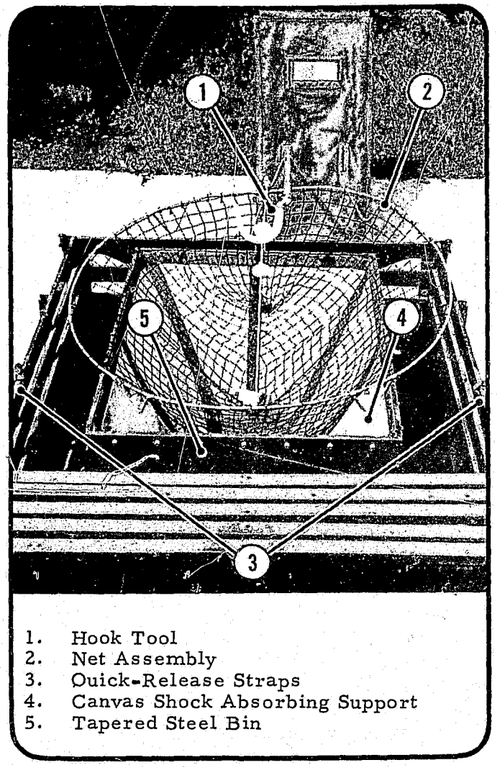
Canadian Armed Forces Trailer

Information supplied by the Canadian Armed Forces indicates that their bomb container is a rectangular, tapered steel bin made of 5/8-inch, SAE 950 steel plate. A net, as illustrated in figure 20, is used as a shock-absorbing support for the bomb while in the bomb container. The bomb container is mounted on a standard, military ¾-ton cargo trailer, which is shown in figure 21. A disadvantage associated with the rectangular construction of the bin was discussed earlier in the section covering the Columbus bomb trailer.

Battelle/IACP Prototype Trailer

As an outgrowth of a 1970 conference attended by major city bomb technicians, personnel of the IACP, and scientists of the Battelle Memorial Institute, Columbus, Ohio, it was agreed that the design of an effective, low-cost bomb transporter was needed by many jurisdictions. The Police Weapons Center, an IACP program funded by the National Institute of Law Enforcement and Criminal Justice, subsequently contracted with Battelle Memorial Institute to design, construct, and evaluate a prototype bomb transporter that could be locally manufactured using standard specifications and materials. It is anticipated that this unit will cost between $2,000 and $3,000, which is considered to be within budgetary limitations of most public safety agencies.

. The bomb container will be cylindrical, with a closed, dish-shaped bottom section and an open, dish-shaped top. An artist's conception of this design is provided in figure 22. The container will be



1. Hook Tool
2. Net Assembly
3. Quick-Release Straps
4. Canvas Shock Absorbing Support
5. Tapered Steel Bin

Figure 20
NET ASSEMBLY, CANADIAN ARMED FORCES TRAILER

approximately 6 feet in diameter and 5 feet high. These dimensions were suggested by Battelle and stem from research studies concerning optimum diameters and depths for bomb containers. Considerations were given to the volume-verses-pressure problem of a bomb detonation, the angles at which a significant portion of the fragmentation might escape, and the velocity of these fragments, as well as to a scientific application of formulae pertaining to the strengthening of the sections of the wall of the bomb container at the point of greatest stress due to the blast pressure wave.

Earlier Battelle studies also recommended the inclusion of an annular lip at the open end of the bomb container to deflect a major portion of the predicted fragmentation as well as an inner and an outer wall for the bomb container, consisting of a relatively thin-walled inner cylinder separated from the outer cylinder by an annular layering of dry sand. It was agreed that the bottom of the

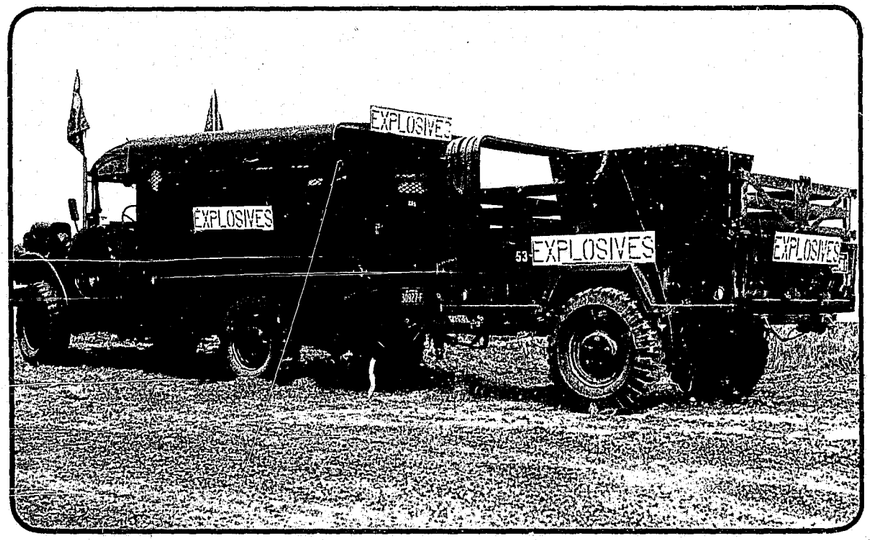


Figure 21
LEFT SIDE VIEW OF CANADIAN ARMED FORCES BOMB TRUCK AND TRAILER

bomb container be sand-filled to slightly above the lower end of the inner cylinder, which is shown in detail in figure 22.

Tests proposed for the unit, trailer-mounted, include the detonation of increasing amounts of explosives (60 percent dynamite) until the bomb transporter suffers appreciable permanent deformation or is destroyed. Advantages of this proposed unit are the same as for any trailer-mounted bomb transporter. It is hoped that additional benefits in safety, economy, and efficiency will be realized through this effort.

DIRECTIONAL CONTAINERS, DOUBLE VENTING

Los Angeles Trailer

The Los Angeles Police Department bomb transport vehicle was constructed in 1958. It consists of a bomb container mounted on a transport trailer. The container, illustrated in figure 23, employs a different application of the directional principle from that previously discussed, in that it is open at both ends and employs double venting, both up and down. The explosive cargo is suspended in a canvas sling located in the center of the container.

The container itself is made of 5/8-inch, heat-treated steel of an ultimate tangible strength of 125,000 p.s.i. and is fabricated with a full penetration double weld. It is 3 feet 6 inches in diameter

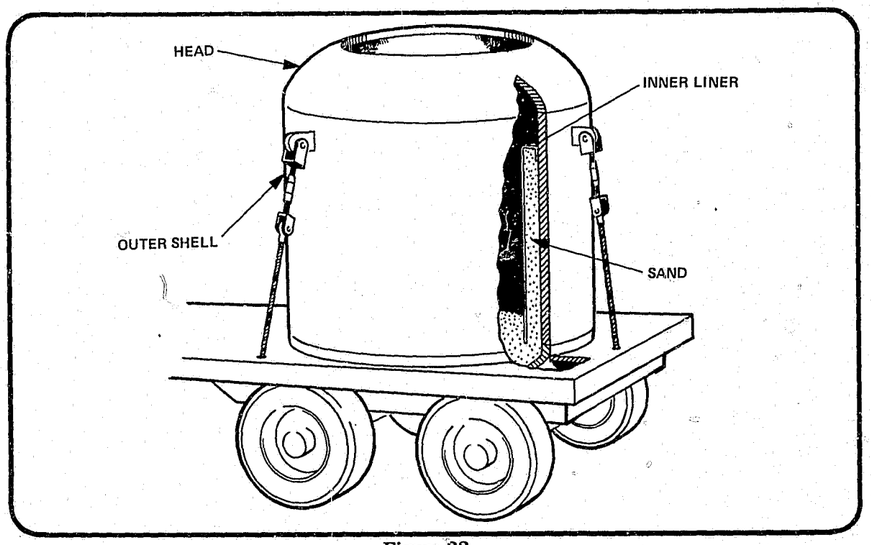


Figure 22
ARTIST'S CONCEPTION OF THE BATTELLE/IACP TRAILER

Figure 23
LOS ANGELES BOMB TRAILER ATTACHED TO BOMB UNIT TRUCK

and 5 feet deep and is mounted on the bomb transport trailer with four 90-degree angle brackets of 5/8-inch steel plate welded onto the outside of the bomb container. Drawings of the Los Angeles trailer are reproduced in figure 24.

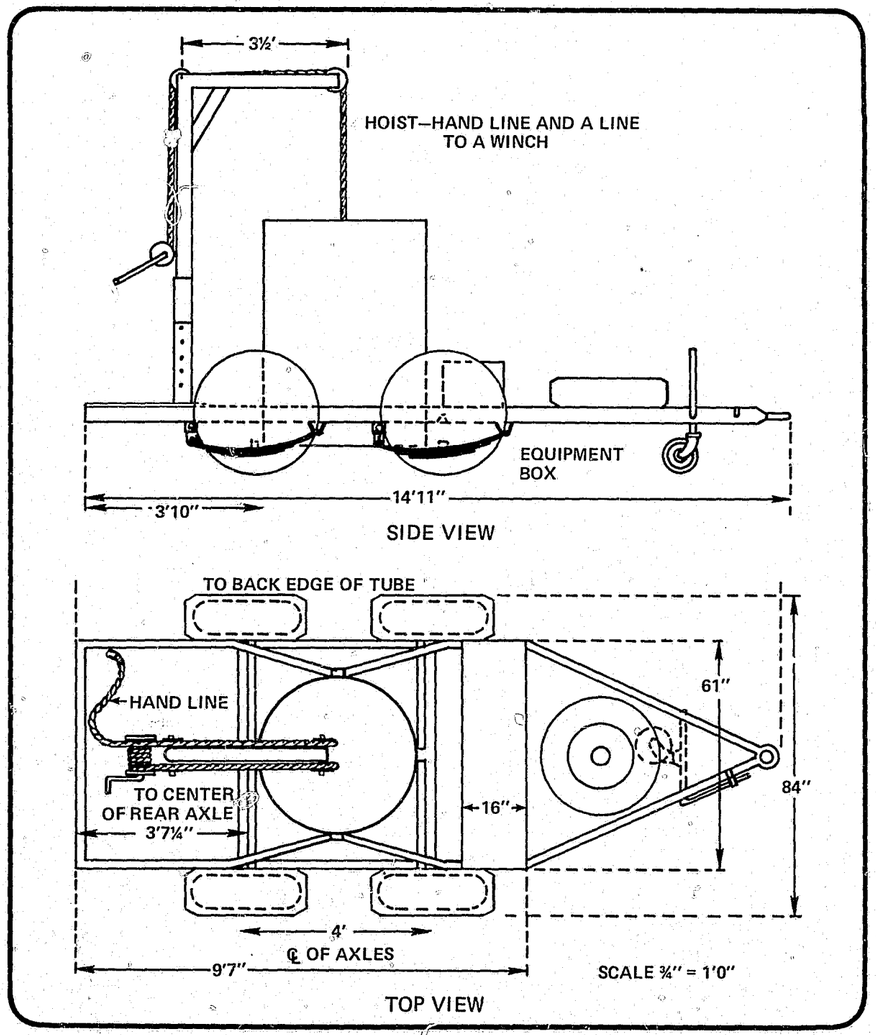


Figure 24
DRAWINGS OF THE LOS ANGELES TRAILER

CONTINUED

2 OF 3

The unit also features a small hand-operated crane mounted on the rear of the trailer. The crane, as shown in figure 25, is used to lower explosive devices into the canvas sling.

The trailer can be towed by any light truck or passenger car with standard ball and socket attachments.

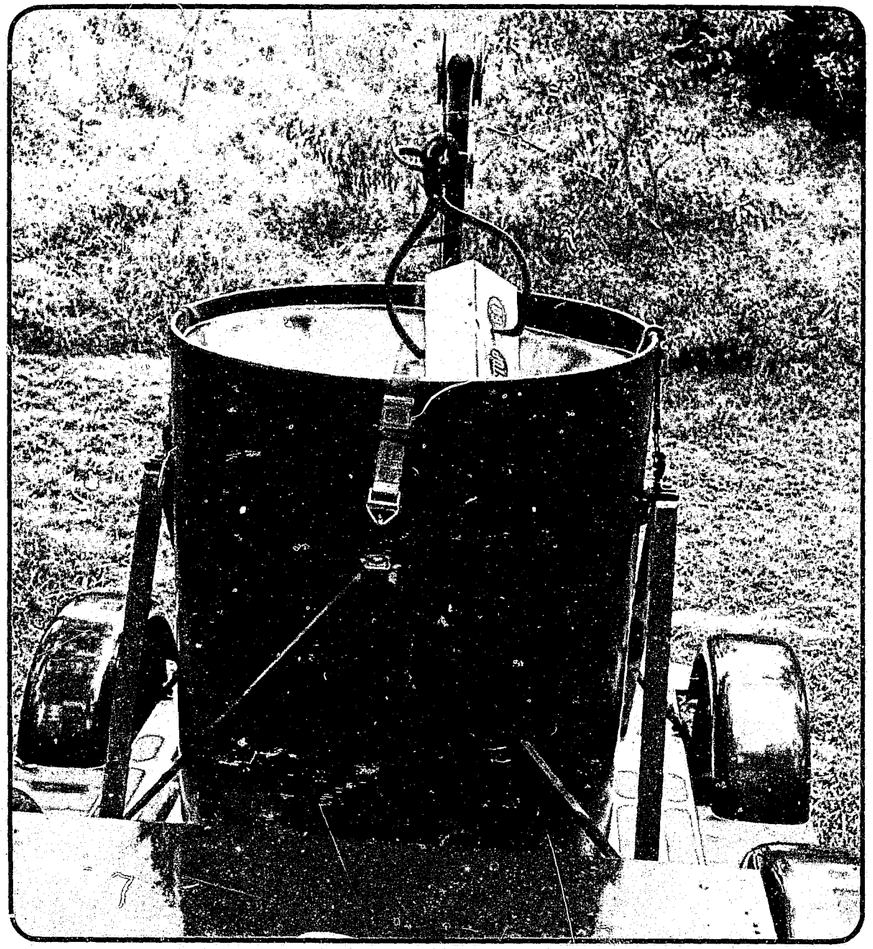


Figure 25
BOMB HANDLING RIG ON LOS ANGELES TRAILER

The Los Angeles bomb container has been successfully tested with 5 sticks of 40 percent dynamite. In operational use, however, high velocity fragments coming out of the bottom of the bomb container and deflected off the road surface may present a potential hazard to personnel and structures nearby. The advantages of this bomb container and carrier construction are reflected in its light weight, mobility, simplicity of design and manufacture, and low cost (under $2,000).

Montreal, Canada, Trailer

The Montreal Police bomb squad uses the same type of bomb container and bomb transporter as does Los Angeles. The bomb container on the Montreal unit, however, is made of ¾-inch mild steel, instead of 5/8-inch heat-treated steel and is of the same depth and diameter. To reduce direct handling risks, the Montreal bomb container, illustrated in figure 26, is fitted with a remotely-opened, quick-release canvas transporting sling which allows the bomb to be dropped to the ground after arriving at a safe area. The advantages and disadvantages of this unit are similar to those discussed in the section covering the Los Angeles bomb vehicle.

Figure 26
MONTREAL BOMB TRAILER WITH TRUCK AND MAJOR EQUIPMENT ITEMS

Improvised Truck or Trailer

In 1970, an improvised bomb container, built of used aircraft tires, was designed and tested by the United States Marine Corps EOD Team at Cherry Point Marine Air Station, North Carolina. The bomb container was constructed of three or four dirt-filled (later revised to dry sand) used aircraft tires, tightly tied down with a rope (later chained) to a metal pallet. The pallet and tires can be used on either a trailer or a truck, with a bed of approximately one foot of dry sand underneath the pallet. Drawings of this unit are included as figures 27 and 28.

The unit was tested using, in separate tests, up to seven sticks of dynamite, two pounds of black powder, and three high-explosive 60 mm mortar shells. The tests indicated a significant reduction and entrapment of horizontally projected fragments as well as a reduction in direct horizontal blast pressure. A bomb blanket over the top of the tires would serve to retard fragmentation. Greater detail on this improvised bomb container may be found in Technical Bulletin 5-70 (U), National Bomb Data Center.

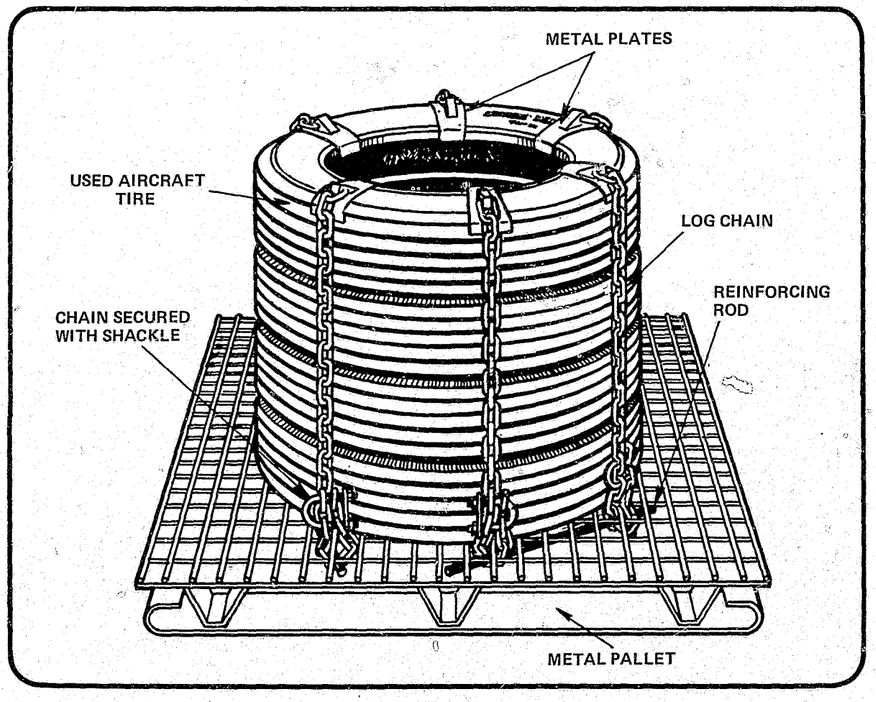


Figure 27
IMPROVISED BOMB CARRIER

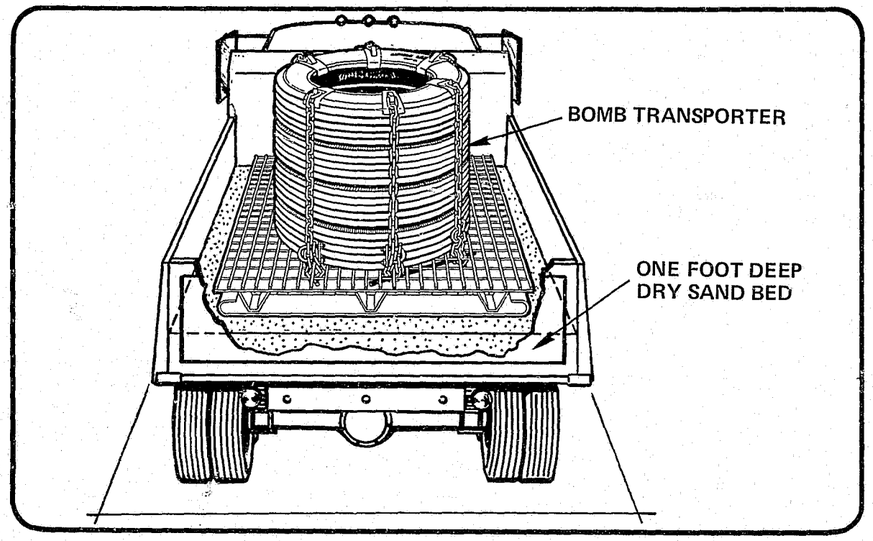


Figure 28
IMPROVISED BOMB CARRIER MOUNTED ON TRUCK BED

POLICE WEAPONS CENTER PUBLICATIONS

The following publications are available upon request at no cost unless otherwise indicated.

REPORT SERIES

1-70 *Selected Basic Reference Bibliography*
2-70 *Protective Masks*
3-70 *Submachine Guns in Police Work*
4-70 *Water Cannon*
5-70 *Police Body Armor*
6-70 *Bomb Transport Vehicles*
7-70 *A Survey of Police Weapons Data*

REPRINT SERIES

1-70 *Procedures for the Sale of Military Weapons and Protective Equipment to Public Safety Agencies*

CHEMICAL AGENTS SERIES

Police Chemical Munitions Handbook
Police Chemical Agents Manual ($1.50)
CS Characteristics (Brochure)
CS Decontamination (Brochure)

CHEMICAL AGENTS REPRINT SERIES

Toxicology of CN, CS and DM, Directorate of Medical Research, U.S. Army
Nonlethal Chemical Agents, Joseph F. Coates
Considerations in the Use of Irritants in Law Enforcement, Richard E. Reinnagel

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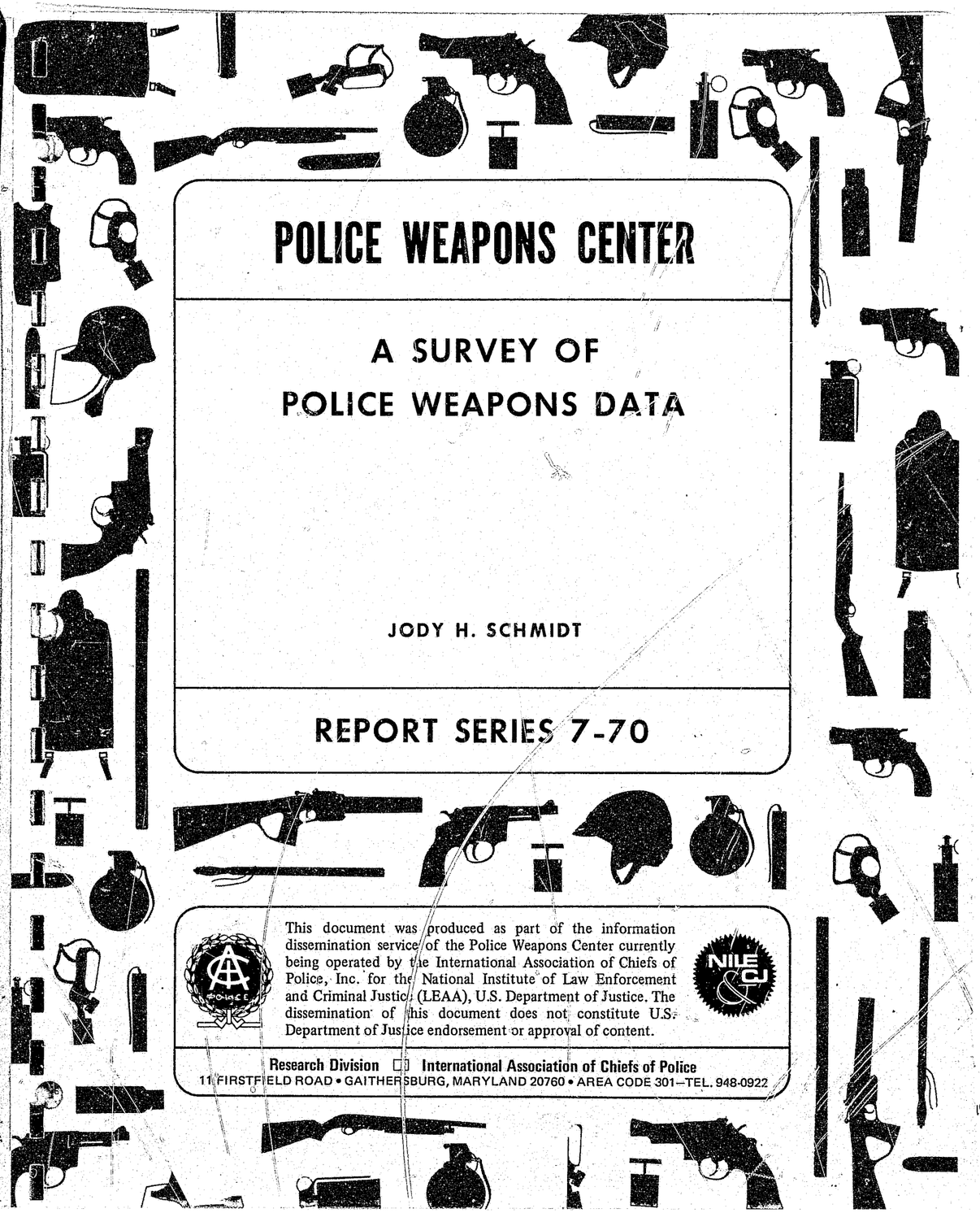
- *Protective Helmets*
- *Barricade Projectiles*
- *Urban Assault Tactics*
- *Police Shotguns*



POLICE WEAPONS CENTER

A SURVEY OF POLICE WEAPONS DATA

JODY H. SCHMIDT

REPORT SERIES 7-70

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CONTENTS

A SURVEY OF POLICE WEAPONS DATA

INTRODUCTION

Background

During the summer of 1970, the Police Weapons Center of the International Association of Chiefs of Police sent a "Police Weapons Center Survey" to police departments throughout the United States. The questionnaires were mailed to 2,564 police departments in the nine standard geographical regions. The jurisdictions of these departments ranged in population size from less than 25,000 to over 1,000,000. The police forces that were asked to cooperate included municipal, county, and state agencies. However, by far the greatest number of participants were city and township departments. It was requested that each recipient of the questionnaire appropriately and as fully as possible, fill it in and return it to the IACP in Washington, D.C. The return process took place throughout the fall of 1970 and was completed by December, 1970.

The survey form itself was divided into two main sections. Information supplied in the initial part, shown in figure 1, was to be used to assist the Police Weapons Center in establishing program priorities and effectively allocating available resources. Each agency was asked to review a 22-category list of police weapons and protective equipment and then assign a priority to the five categories about which its department most needed information.

The five categories cited were to be ranked in the order of greatest need (first, second, third, etc.). Then, in this same section there were five columns to permit the individual department to more explicitly indicate the type of information needed on each category of equipment. The columns read: procurement specifications, comparative testing, tactical use data, training material, and cost data.

The purpose of the second section of the questionnaire was to enable the Police Weapons Center to collect and evaluate national data on the current usage of different manufacturers' weapons and protective equipment. Figure 2 shows this section which was located on the reverse side of the form and broken down into twelve equipment item categories. The departments were to identify the manufacturer or brand; the model or identifying data; the caliber, size, or gauge; and the approximate number of the item that each force is using or has on hand.

In analysis of the returned survey forms, what has been attempted is digestion of the material and compilation of relevant data. The equipment categories identifying the information most frequently needed have been noted and ranked. Moreover, the specific type of information required most often by the department has been examined in a similar manner. Finally, correlations between particular information needs and population groups or regional locations have been determined where relevant.

The analysis process was somewhat impeded by two factors which should be noted. The greatest debilitating factor deals with the return rate, which was just over 15 per 100. Of the 2,564 mailed

Police Weapons Center Survey

PLEASE SEND THIS DEPARTMENT ALL POLICE WEAPONS CENTER PUBLICATIONS ☐ YES ☐ NO

DEPARTMENT _____

STREET _____

CITY _____ STATE _____ ZIP _____

POPULATION SERVED
a ☐ OVER 1,000,000
b ☐ 250,000-999,999
c ☐ 249,999-100,000
d ☐ 99,000-50,000
e ☐ 49,999-25,000
f ☐ 10,000-24,999
g ☐ UNDER 9,999

1. To assist us in establishing PWC program priorities and effectively allocating available resources, we would like you to review the following list of equipment and assign a priority to the five categories about which your department most needs information. (The most important category should be numbered 1 in column **A**, with second choices numbered in sequence.) When you have selected and assigned the 5 priority items, please use column **C** to indicate what kind(s) of data you need on each of the five selected equipment categories.

A PRIORITY	B EQUIPMENT CATEGORIES	C CHECK TYPE OF INFORMATION NEEDED (√)				
		PROCUREMENT SPECIFICATIONS 1	COMPARATIVE TESTING 2	TACTICAL USE DATA 3	TRAINING MATERIAL 4	COST DATA 5
A	Handguns					
B	Shotguns					
C	Rifles					
D	Automatic Weapons					
E	Ammunition					
F	Aerosol Irritant Projectors (MACE-Type)					
G	Projectiles					
H	Grenades					
I	Bulk Dispensers					
J	Nightsticks					
K	Blackjacks, Saps					
L	Riot Batons					
M	Special Purpose Batons					
N	Bombs					
O	Military Munitions					
P	Incendiary Devices					
Q	Body Armor					
R	Vehicle Armor					
S	Masks					
T	Helmets					
U	Clothing					
V	OTHER (Please List)					

OVER

Figure 1
POLICE WEAPONS CENTER SURVEY, PART I

Police Weapons Center Survey (side 2)

2. In order to collect and evaluate data on police weapons and protective equipment we need to know what equipment is being used. Please use the following form or a separate sheet of paper to identify the brand and model of the *majority* of each of the equipment items being used by your department.

EQUIPMENT ITEM	MANUFACTURER OR BRAND	MODEL OR IDENTIFYING DATA	CALIBER, GAUGE, SIZE	APPROXIMATE NUMBER ON HAND
Handguns				
Shotguns				
Rifles				
Automatic Weapons				
Aerosol Irritant Chemical Projectors (MACE-Type)				
Chemical Grenades				
Chemical Projectiles				
Nightsticks				
Riot Batons				
Body Armor				
Gas Masks				
Riot Helmets				

Figure 2
POLICE WEAPONS CENTER SURVEY, PART II

forms, only 388 were returned or could be used throughout the compilation-analysis procedure.[1] A further limitation was encountered due to some illegible forms and the improper filling in of others.

Responses

The overall return rate for the survey is 15.60 percent or 400 of the 2,564 mailed.[2] On a regional basis, the Pacific zone with Alaska, California, Hawaii, Oregon, and Washington had the highest return rate, 68.06 percent. This is contrasted with an extremely low return rate of 2.76 percent from the states of Alabama, Kentucky, Mississippi, and Tennessee of the East-South Central zone. As illustrated in figure 3, the South Atlantic region had the second highest ratio followed by: East-North Central, Middle Atlantic, New England, West-North Central, West South Central, and Mountain.

In addition to the regional categories, population group distribution has also been considered. The returned survey forms were filed in five different categories based on the number of inhabitants within the departments' jurisdiction.

The definitions of these five categories of jurisdiction are:

Less than 25,000	100,000 to 249,999
25,000 to 49,999	250,000 or more
50,000 to 99,999	

Figure 4 more clearly reveals the population breakdowns while also examining responses per number sent for each grouping. The crosshatched area of each bar denotes the proportion of surveys in each population group that were returned and analyzed. Figure 5 shows the exact number of those surveys sent and returned according to each population category. The percentage of respondents was highest in the 50,000 to 99,999 grouping with 58.6 percent of the 512 mailed surveys being returned. The reverse was represented by the category which returned 133 of the 1,178 surveys sent for a ratio of 11 to 5. The mean response figure, once again, is 15.6 percent.

Summary

The responding departments strongly indicated that training materials for most types of weapons were of great interest. Within the first priority considerations, 81.2 percent of the departments were interested in such training material.

The single weapon of greatest interest was the handgun. This was followed by bombs, shotguns, aerosol irritant projectors, and body armor.

[1] Sixteen additional forms were received late, making the total 404, and, although the time factor prevented their evaluation in the earlier phases of the operation, they will be used in the analysis of the second part of the survey of equipment items in current use by departments and also in the regional return breakdown to be discussed immediately.

[2] In addition, four unsolicited replies were received, two of which were from Canada.

Region	Sent*	Returned**	Percent
Pacific: Alaska, California, Hawaii, Oregon, Washington	119	81	68.06
South Atlantic: Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia, Washington, D.C.	144	37	25.69
East-North Central: Illinois, Indiana, Michigan, Ohio, Wisconsin	553	93	16.81
Middle Atlantic: New Jersey, New York, Pennsylvania, Puerto Rico, Virgin Islands	426	63	14.78
New England: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont	219	31	14.16
West-North Central: Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota	309	43	13.91
West-South Central: Arkansas, Louisiana, Oklahoma, Texas	222	22	09.90
Mountain: Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming	319	23	07.21
East-South Central: Alabama, Kentucky, Mississippi, Tennessee	253	7	02.76
Total	2,564	400	15.60

*While the figures representing returned surveys are correct, they often are not in agreement with the figures used in later analysis. Due to illegibility, incorrect filling of survey forms or inadequate responses, some returns were disregarded. This accounts for the discrepancy between response figures and those of the analysis.

**The four unsolicited center surveys received from departments in two small jurisdictions and Quebec, Canada are not computed here. However, the survey information contained was useful and consistent with other returns from the United States, and was, therefore, used in the analysis.

Figure 3
REGIONAL RETURN RATIOS

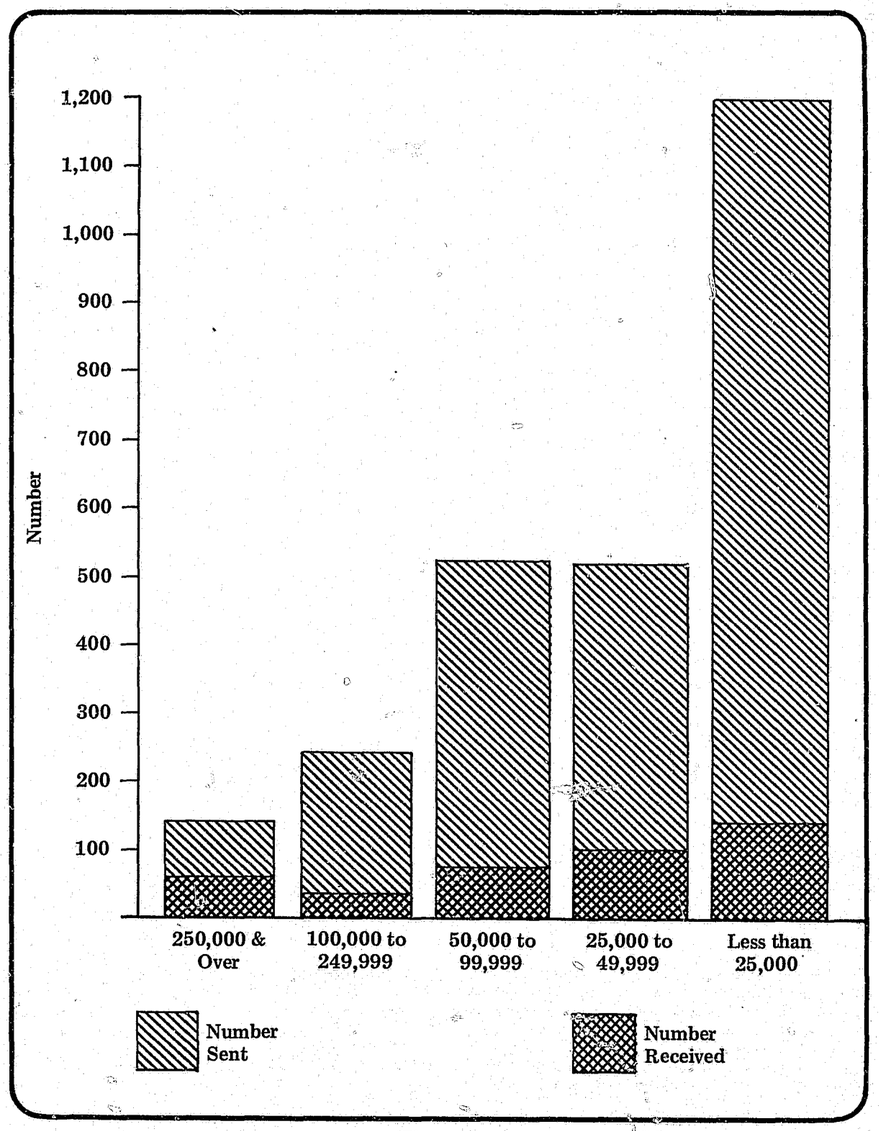

Figure 4
RESPONSES PER NUMBER SENT BY POPULATION CATEGORIES

Responses	Population Category					
	250,000 or more	100,000-249,000	50,000-99,999	25,000-49,999	Less than 25,000	Total
Number Sent	135	234	512	505	1,178	2,564
Percent of Those Sent	5.27	9.13	19.97	19.69	45.94	100.00
Number Received	61	34	74	96	135	400
Percent of Those Received	15.25	8.50	18.50	24.00	33.75	100.00
Response Rate	45.18	14.52	14.45	19.00	11.46	15.60

Figure 5
RESPONSES BY POPULATION CATEGORIES

When the type of weapon, the type of data, and the associated priority were all considered simultaneously, it was found that training material on handguns was considered more needed than any other equipment-oriented data. In descending order, it was found that the following combinations followed training materials on handguns in importance:

2. handguns/comparative testing,
3. bombs/training,
4. handguns/tactical use,
5. shotguns/training.

The presence of handguns and demands for 3 of the 5 data types in the five most important combinations suggests the elemental importance of this weapon in police work.

In terms of the analytical approach of this report, statistical measurements such as the standard deviation, chi-square, F-tests, and linear regression were not applied in either a descriptive or inductive sense. The data, however, are arranged in such a manner that if the application of such methods is warranted, this subsequent analysis may be easily performed.

INFORMATION REQUIREMENTS

General Data Needs

Figure 6 shows the gross interest of departments by equipment type. Because each of the 400 departments were to have chosen its top five priorities in equipment data needs, a total of 2,000 entries should have resulted. Only 388 returns containing a total of 1,922 entries, however, proved usable. In figure 6 the type of equipment appears in descending order depending on the number of times it was chosen.

Equipment	Times Chosen	Equipment	Times Chosen
1. Handguns	184	12. Projectiles	71
2. Bombs	164	13. Helmets	66
3. Body Armor	157	14. Clothing	62
4. Aerosol Irritant Projectors	155	15. Bulk Dispensers	61
5. Shotguns	151	16. Vehicle Armor	60
6. Ammunition	136	17. Military Munitions	44
7. Incendiary Devices	122	18. Riot Batons	38
8. Grenades	108	19. Nightsticks	31
9. Automatic Weapons	103	20. Special Purpose Batons	14
10. Rifles	91	21. Other	11
11. Masks	85	22. Blackjacks, Saps	8
		Total	1,922

Figure 6
SELECTION OF EQUIPMENT TYPES

Once having indicated the priority of a chosen equipment item, departments were instructed to state the specific type of data needed for each type of equipment. No restriction or priorities were applied in the case of the type of data needed so that a department could select any one or all five data types with respect to a specific piece of equipment. The departments' responses with respect to the type of data needed are shown in figure 7.

An examination of figures 7 and 9 shows that training material is the type of data in greatest demand by the departments. The strength of this demand will be shown in a later section. At this point, however, the relative strength of the demand for training materials can be partially shown by ranking each type of data with respect to equipment types and summing the rank positions. For example, in figure 7 for handguns, training ranks first, comparative testing second, tactical use third, cost data fourth, and procurement specifications fifth. If this analysis is performed for each equipment type and the ranking total, figure 8 results.

Rearranging these data types in descending order by the median position of each data type with respect to the rankings we find:

1. Training Material
2. Tactical Use Data
3. Comparative Testing
4. Cost Data
5. Procurement Specifications

Priority Analysis

Because the surveyed departments were first to select their respective five most important equipment categories and secondly to place them in order of importance (from first to fifth), it is

Equipment	Procurement Specifications	Comparative Testing	Tactical Use Data	Training Material	Cost Data	Total
Handguns	90	134	124	152	93	593
Shotguns	57	89	118	136	59	459
Rifles	46	55	61	75	50	287
Automatic Weapons	62	65	91	88	69	375
Ammunition	52	112	68	80	78	390
Aerosol Irritant Projectors	76	114	126	129	84	529
Projectiles	29	41	53	43	35	201
Grenades	56	68	88	69	55	336
Bulk Dispensers	33	42	27	48	44	194
Nightsticks	13	15	17	22	15	82
Blackjacks, Saps	3	3	3	4	4	17
Riot Batons	10	8	24	10	9	61
Special Purpose Batons	9	1	3	7	6	26
Bombs	42	56	104	148	44	394
Military Munitions	27	20	26	18	24	115
Incendiary Devices	31	43	77	99	30	280
Body Armor	122	133	119	104	127	605
Vehicle Armor	48	46	35	42	47	218
Masks	65	68	65	68	69	335
Helmets	53	42	46	40	42	223
Clothing	42	45	41	33	46	217
Other	5	6	5	5	4	25
Total	971	1,206	1,321	1,420	1,034	5,952

Figure 7
TYPE DATA NEEDED

possible to gain an extremely specific indication of the department's relative interest with respect to equipment and the type of data associated with that equipment. In figure 10 each type of equipment is shown with a breakdown of the priorities assigned to it by the responding departments. Equipment types within this table appear in descending order based on the number of times individual departments placed them first in priority.

The order of listing in figure 10 should be compared with that in figure 6 on page 8 where equipment types were listed in order based upon the total times each was chosen. The order of the first four equipment types in both tables is identical, but beyond this point deviations in order based upon departmental priority become apparent.

Data Type	Ranking				
	First	Second	Third	Fourth	Fifth
Procurement Specifications	4	2	3	5	8
Comparative Testing	3	3	12	3	1
Tactical Use Data	4	9	2	5	2
Training Material	9	8	—	1	4
Cost Data	3	3	6	5	5

Figure 8
RANKING OF DATA TYPES BASED UPON SELECTION

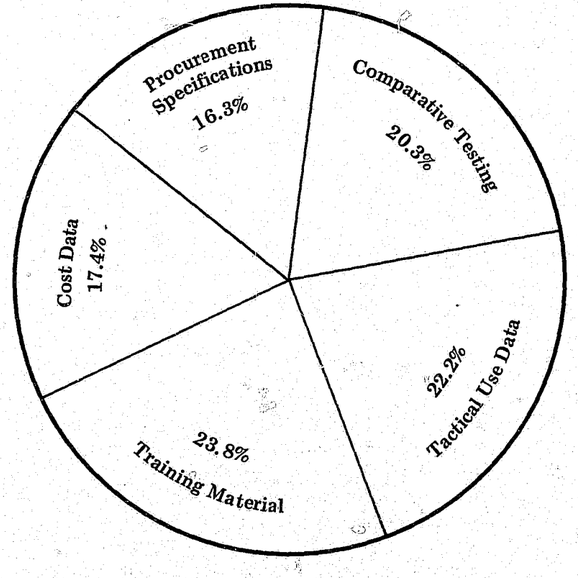

Figure 9
PERCENTAGE BREAKDOWN OF FIRST FIVE REQUESTED TYPES OF DATA

Equipment	1st	2nd	3rd	4th	5th	TOTAL
Handguns	113 (29.1%)	22 (5.7%)	16 (4.1%)	19 (4.9%)	14 (3.6%)	184
Bombs	66 (17.0)	26 (6.7)	29 (7.5)	25 (6.4)	18 (4.6)	164
Body Armor	31 (8.0)	23 (5.9)	29 (7.5)	40 (10.3)	34 (8.8)	157
Aerosol Irritant Projector	30 (7.7)	31 (8.0)	35 (9.0)	32 (8.2)	27 (7.0)	155
Ammunition	24 (6.2)	28 (7.2)	22 (5.7)	20 (5.2)	42 (10.8)	136
Shotguns	22 (5.7)	71 (18.3)	30 (7.7)	15 (3.9)	13 (3.4)	151
Automatic Weapons	20 (5.2)	19 (4.9)	26 (6.7)	26 (6.7)	12 (3.1)	103
Grenades	13 (3.4)	19 (4.9)	13 (3.4)	33 (8.5)	30 (7.7)	108
Incendiary Devices	11 (2.8)	47 (12.1)	22 (5.7)	21 (5.4)	21 (5.4)	122
Bulk Dispensers	9 (2.3)	9 (2.3)	11 (2.8)	18 (4.6)	14 (3.6)	61
Masks	9 (2.3)	14 (3.6)	20 (5.2)	19 (4.9)	23 (5.9)	85
Projectiles	8 (2.1)	15 (3.9)	17 (4.4)	15 (3.9)	16 (4.1)	71
Helmets	6 (1.5)	10 (2.6)	16 (4.1)	10 (2.6)	24 (6.2)	66
Rifles	6 (1.5)	18 (4.6)	35 (9.0)	21 (5.4)	11 (2.8)	91
Clothing	5 (1.3)	5 (1.3)	16 (4.1)	11 (2.8)	25 (6.4)	62
Riot Batons	5 (1.3)	6 (1.5)	9 (2.3)	12 (3.1)	6 (1.5)	38
Vehicle Armor	4 (1.0)	10 (2.6)	14 (3.6)	16 (4.1)	16 (4.1)	60
Nightsticks	3 (0.8)	3 (0.8)	4 (1.0)	9 (2.3)	12 (3.1)	31
Other	3 (0.8)	1 (0.3)	2 (0.5)	1 (0.3)	4 (1.0)	11
Blackjacks, Saps	0 (0.0)	1 (0.3)	2 (0.5)	2 (0.5)	3 (0.8)	8
Military Munitions	0 (0.0)	8 (2.1)	13 (3.4)	13 (3.4)	10 (2.6)	44
Special Purpose Batons	0 (0.0)	0 (0.0)	5 (1.3)	4 (1.0)	5 (1.3)	14
Total	388	386	386	382	380	1,922

Figure 10
TOTAL AMOUNT OF FIRST FIVE CHOICES FOR EACH TYPE OF EQUIPMENT

In figure 11 each type of equipment is shown with respect to both priority and type of data needed. The importance of training material is once again quite evident by its dominant appearance in conjunction with a first priority ranking for most types of equipment. The full significance of this dominance will be examined in the sections entitled "Rank Priority/Type Data" and "Total Priority."

Regional Analysis

Due to the limited number of returns from certain regions, a regional analysis attempting to show variations in equipment and/or data interests is of negligible value. Instead, each region has been examined solely on the basis of equipment and data stated to be of first priority. The results are shown in figure 12 and figure 13.

These partial returns seem to indicate that variations among regions are of no great significance. Due to the lack of sufficient data, however, this cannot be clearly established.

Choices by Population Groups

Interest in weapons or equipment does not tend to vary much by population group with the following exceptions:

- Interest in bomb data seems considerably lower for departments with jurisdictions ranging in population from 25,000 – 49,999 than in other population groups.
- Interest in shotguns is far higher in the smaller jurisdictions than the larger.
- Interest in ammunition is higher in the larger jurisdiction than the smaller.
- There seems to be a far higher interest in masks in jurisdictions ranging in population from 100,000 – 249,999 than in other population groups and very little interest in this item in the jurisdictions under 25,000.

In figure 14 the ten equipment items chosen most often are compared to their position with respect to each population group. Note that while the category handguns is not the first choice for all population groups, it is still an extremely high selection in all. The category bombs is not far behind.

In figures 15-19 the equipment choices for each population group are broken down by the priority the respondents assigned to them (1-5). Note that the category handguns has the greatest number of first priority selections in every population group while the category bombs is again consistently second.

Total Requested		Procurement Specifications	%	Comparative Testing	%	Tactical Use Data	%	Training Material	%	Cost Data	%
Handguns:											
1ST	113	51	(45.1)	82	(72.6)	74	(65.5)	92	(81.4)	56	(49.6)
2ND	22	13	(59.1)	16	(72.7)	17	(77.3)	21	(90.9)	11	(50.0)
3RD	16	8	(50.0)	13	(81.3)	10	(62.5)	13	(81.3)	10	(62.5)
4TH	19	8	(42.1)	11	(57.9)	13	(68.4)	15	(78.9)	8	(42.1)
5TH	14	10	(71.4)	12	(85.7)	10	(71.4)	12	(85.7)	8	(57.1)
	184	90	(48.9)	134	(72.8)	124	(67.4)	152	(82.6)	93	(50.5)
Shotguns:											
1ST	22	8	(36.4)	9	(40.9)	17	(77.3)	21	(95.5)	11	(50.0)
2ND	71	24	(33.8)	41	(57.7)	55	(77.5)	66	(93.0)	28	(39.4)
3RD	30	14	(46.7)	21	(70.0)	25	(83.3)	27	(90.0)	10	(33.3)
4TH	15	6	(40.0)	10	(66.7)	12	(80.0)	10	(66.7)	5	(33.3)
5TH	13	5	(38.5)	8	(61.5)	9	(69.2)	12	(92.3)	5	(38.5)
	151	57	(37.6)	89	(58.9)	118	(78.2)	136	(90.1)	59	(39.1)
Rifles:											
1ST	6	3	(50.0)	4	(66.7)	0	(0.0)	5	(83.3)	3	(50.0)
2ND	18	11	(61.1)	10	(55.6)	14	(77.8)	17	(94.4)	12	(66.7)
3RD	35	17	(48.6)	23	(65.7)	29	(82.9)	27	(77.1)	18	(51.4)
4TH	21	10	(47.6)	13	(61.9)	18	(85.7)	17	(81.0)	12	(57.1)
5TH	11	5	(45.5)	5	(45.5)	0	(0.0)	9	(81.8)	5	(45.5)
	91	46	(50.6)	55	(60.4)	61	(67.0)	75	(82.4)	50	(55.0)
Automatic Weapons:											
1ST	20	11	(55.0)	11	(55.0)	18	(90.0)	18	(90.0)	14	(70.0)
2ND	19	15	(78.9)	12	(63.2)	17	(89.5)	15	(78.9)	16	(84.2)
3RD	26	15	(57.7)	16	(61.5)	22	(84.6)	23	(88.5)	14	(53.8)
4TH	26	15	(57.7)	19	(73.1)	23	(88.5)	22	(84.6)	17	(65.4)
5TH	12	6	(50.0)	7	(58.3)	11	(91.7)	10	(83.3)	8	(66.7)
	103	62	(60.2)	65	(63.1)	91	(88.4)	88	(85.4)	69	(67.0)
Ammunition:											
1ST	24	14	(58.3)	20	(83.3)	16	(66.7)	15	(62.5)	17	(70.8)
2ND	28	2	(7.2)	17	(60.7)	0	(0.0)	20	(71.4)	17	(60.7)
3RD	22	8	(36.4)	20	(90.9)	14	(63.6)	13	(59.1)	12	(54.5)
4TH	20	10	(50.0)	17	(85.0)	16	(80.0)	12	(60.0)	9	(45.0)
5TH	42	18	(42.9)	38	(90.5)	22	(52.4)	20	(47.6)	23	(54.8)
	136	52	(38.2)	112	(82.4)	68	(50.0)	80	(58.8)	78	(57.4)

Figure 11
FIRST FIVE CHOICES FOR EACH EQUIPMENT TYPE COMPARED TO DATA TYPE REQUESTS

Total Requested		Procurement Specifications	%	Comparative Testing	%	Tactical Use Data	%	Training Material	%	Cost Data	%
Aerosol:											
1ST	30	19	(63.3)	26	(86.7)	28	(93.3)	28	(93.3)	19	(63.3)
2ND	31	15	(48.4)	21	(67.7)	26	(83.9)	26	(83.9)	18	(58.1)
3RD	35	16	(45.7)	24	(68.6)	28	(80.0)	28	(80.0)	19	(54.3)
4TH	32	13	(40.6)	25	(78.1)	24	(75.0)	25	(78.1)	15	(46.9)
5TH	27	13	(48.1)	18	(66.7)	20	(74.1)	22	(81.5)	13	(48.1)
	155	76	(49.0)	114	(73.5)	126	(81.3)	129	(83.2)	84	(54.2)
Projectiles:											
1ST	8	3	(37.5)	5	(62.5)	0	(0.0)	0	(0.0)	6	(25.0)
2ND	15	5	(33.3)	7	(46.7)	13	(86.7)	13	(86.7)	7	(46.7)
3RD	17	7	(41.2)	9	(52.9)	13	(76.5)	15	(88.2)	8	(47.1)
4TH	15	7	(46.7)	8	(53.3)	13	(86.7)	0	(0.0)	7	(46.7)
5TH	16	7	(43.8)	12	(75.0)	14	(87.5)	15	(93.8)	7	(43.8)
	74	29	(39.2)	41	(55.4)	53	(71.6)	43	(58.1)	35	(47.3)
Grenades:											
1ST	13	8	(61.5)	8	(61.5)	11	(84.6)	0	(0.0)	6	(46.2)
2ND	19	7	(36.8)	9	(47.4)	15	(78.9)	16	(84.2)	9	(47.4)
3RD	13	6	(46.2)	7	(53.8)	11	(84.6)	0	(0.0)	9	(69.2)
4TH	33	16	(48.5)	23	(69.7)	25	(75.8)	28	(84.8)	15	(45.5)
5TH	30	19	(63.3)	21	(70.0)	26	(86.7)	25	(83.3)	16	(53.3)
	108	56	(51.9)	68	(63.0)	88	(81.5)	69	(63.9)	55	(50.9)
Bulk Disp.:											
1ST	9	5	(55.6)	6	(66.7)	7	(77.8)	6	(66.7)	7	(77.8)
2ND	9	6	(66.7)	8	(88.9)	8	(88.9)	6	(66.7)	7	(77.8)
3RD	11	5	(45.5)	7	(63.6)	0	(0.0)	10	(90.9)	8	(72.7)
4TH	18	10	(55.6)	13	(72.2)	0	(0.0)	16	(88.9)	13	(72.2)
5TH	14	7	(50.0)	8	(57.1)	12	(85.7)	10	(71.4)	9	(64.3)
	61	33	(54.1)	42	(68.9)	27	(44.3)	48	(78.7)	44	(72.1)
Nightsticks:											
1ST	3	1	(33.3)	2	(66.7)	0	(0.0)	0	(0.0)	1	(33.3)
2ND	3	2	(66.7)	1	(33.3)	2	(66.7)	0	(0.0)	1	(33.3)
3RD	4	2	(50.0)	2	(50.0)	0	(0.0)	3	(75.0)	3	(75.0)
4TH	9	2	(22.2)	1	(11.1)	5	(55.6)	8	(88.9)	3	(33.3)
5TH	12	6	(50.0)	9	(75.0)	10	(83.3)	11	(91.7)	7	(58.3)
	31	13	(41.9)	15	(48.4)	17	(54.8)	22	(71.0)	15	(48.4)

Figure 11
FIRST FIVE CHOICES FOR EACH EQUIPMENT TYPE COMPARED TO DATA TYPE REQUESTS (Continued)

Total Requested		Procurement Specifications	%	Comparative Testing	%	Tactical Use Data	%	Training Material	%	Cost Data	%
Blackjacks, Saps:											
1ST	0	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
2ND	1	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
3RD	2	1	(50.0)	1	(50.0)	1	(50.0)	1	(50.0)	1	(50.0)
4TH	2	1	(50.0)	1	(50.0)	0	(0.0)	1	(50.0)	1	(50.0)
5TH	3	1	(33.3)	1	(33.3)	2	(66.7)	2	(66.7)	2	(66.7)
	8	3	(37.5)	3	(37.5)	3	(37.5)	4	(50.0)	4	(50.0)
Riot Batons:											
1ST	5	1	(20.0)	1	(20.0)	4	(80.0)	0	(0.0)	0	(0.0)
2ND	6	2	(33.3)	2	(33.3)	4	(66.7)	5	(83.3)	2	(33.3)
3RD	9	2	(22.2)	3	(33.3)	6	(66.7)	8	(88.9)	2	(22.2)
4TH	12	3	(25.0)	2	(16.7)	8	(83.3)	0	(0.0)	4	(33.3)
5TH	6	2	(33.3)	0	(0.0)	2	(33.3)	5	(83.3)	1	(16.7)
	38	10	(26.3)	8	(21.1)	24	(63.2)	10	(26.3)	9	(23.7)
Spec. Purpose Batons:											
1ST	0	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
2ND	0	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
3RD	5	2	(40.0)	0	(0.0)	0	(0.0)	4	(80.0)	2	(40.0)
4TH	4	3	(75.0)	1	(25.0)	3	(75.0)	0	(0.0)	0	(0.0)
5TH	5	4	(80.0)	0	(0.0)	0	(0.0)	3	(60.0)	4	(80.0)
	14	9	(64.3)	1	(7.01)	3	(21.4)	7	(50.0)	6	(42.9)
Bombs:											
1ST	66	16	(24.2)	22	(33.3)	42	(63.6)	60	(90.9)	14	(21.2)
2ND	26	6	(23.1)	9	(30.8)	18	(69.2)	33	(88.5)	7	(26.9)
3RD	29	10	(34.5)	12	(41.4)	10	(65.5)	26	(89.7)	12	(41.4)
4TH	25	4	(16.0)	5	(20.0)	14	(56.0)	20	(80.0)	5	(20.0)
5TH	18	6	(33.3)	0	(50.0)	11	(61.1)	10	(83.3)	6	(33.3)
	164	42	(25.6)	56	(34.1)	104	(63.4)	148	(90.2)	44	(26.8)
Military Munitions:											
1ST	0	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
2ND	8	6	(75.0)	4	(50.0)	4	(50.0)	5	(62.5)	6	(75.0)
3RD	13	6	(46.2)	6	(46.2)	7	(53.8)	0	(0.0)	5	(38.5)
4TH	13	10	(76.9)	7	(53.8)	9	(69.2)	9	(69.2)	8	(61.5)
5TH	10	5	(50.0)	3	(30.0)	6	(60.0)	4	(40.0)	5	(50.0)
	44	27	(61.4)	20	(45.5)	26	(59.1)	18	(40.9)	24	(54.5)

Figure 11
FIRST FIVE CHOICES FOR EACH EQUIPMENT TYPE COMPARED TO DATA TYPE REQUESTS (Continued)

Total Requested		Procurement Specifications	%	Comparative Testing	%	Tactical Use Data	%	Training Material	%	Cost Data	%
Incendiary Devices:											
1ST	11	7	(63.6)	7	(63.6)	8	(72.7)	0	(0.0)	4	(36.4)
2ND	47	9	(19.1)	18	(38.3)	29	(61.7)	44	(93.6)	9	(19.1)
3RD	22	7	(31.8)	8	(36.4)	18	(81.8)	20	(90.0)	9	(40.9)
4TH	21	3	(14.3)	6	(28.6)	12	(57.1)	18	(85.7)	4	(19.0)
5TH	21	5	(23.8)	4	(19.0)	10	(52.4)	17	(81.0)	4	(19.0)
	122	31	(25.4)	43	(35.2)	77	(63.1)	99	(81.1)	30	(25.6)
Body Armor:			30.52								
1ST	31	23	(74.2)	23	(74.2)	24	(77.4)	16	(51.6)	26	(83.9)
2ND	23	19	(82.6)	22	(95.7)	19	(82.6)	15	(65.2)	18	(78.3)
3RD	29	22	(75.9)	24	(82.8)	20	(72.4)	20	(72.4)	24	(82.8)
4TH	40	33	(82.5)	37	(92.5)	31	(77.5)	30	(75.0)	32	(80.0)
5TH	34	25	(73.5)	27	(79.4)	25	(73.5)	23	(67.6)	27	(79.4)
	157	122	(77.7)	133	(84.7)	119	(75.8)	104	(66.2)	127	(80.9)
Vehicle Armor:											
1ST	4	3	(75.0)	3	(75.0)	0	(0.0)	2	(50.0)	2	(50.0)
2ND	10	7	(70.0)	6	(60.0)	0	(0.0)	7	(70.0)	9	(90.0)
3RD	14	11	(78.6)	9	(64.3)	12	(85.7)	12	(85.7)	10	(71.4)
4TH	16	14	(87.5)	15	(93.8)	13	(81.3)	10	(62.5)	15	(93.8)
5TH	16	13	(81.3)	13	(81.3)	10	(62.5)	11	(68.8)	11	(68.8)
	60	48	(80.0)	46	(57.5)	35	(58.3)	42	(70.0)	47	(78.3)
Masks:											
1ST	9	6	(66.7)	7	(77.8)	4	(44.4)	8	(88.9)	7	(77.8)
2ND	14	12	(85.7)	10	(71.4)	10	(71.4)	10	(71.4)	13	(92.9)
3RD	20	17	(85.0)	17	(85.0)	18	(90.0)	16	(80.0)	16	(80.0)
4TH	19	13	(68.4)	14	(73.7)	15	(78.9)	14	(73.7)	14	(73.7)
5TH	23	17	(73.9)	20	(87.9)	18	(78.3)	20	(87.0)	19	(82.6)
	85	65	(85.9)	68	(80.0)	65	(76.5)	68	(80.0)	69	(81.2)
Helmets:											
1ST	6	3	(50.0)	4	(66.7)	2	(33.3)	2	(33.3)	4	(66.7)
2ND	10	8	(80.0)	8	(80.0)	8	(80.0)	6	(60.0)	7	(70.0)
3RD	16	13	(81.3)	15	(93.8)	13	(81.3)	14	(87.5)	9	(56.3)
4TH	10	9	(90.0)	0	(0.0)	6	(60.0)	5	(50.0)	6	(60.0)
5TH	24	20	(83.3)	51	(62.5)	17	(70.8)	13	(54.2)	16	(66.7)
	66	53	(80.3)	42	(63.6)	46	(69.7)	40	(60.6)	42	(63.6)

Figure 11
FIRST FIVE CHOICES FOR EACH EQUIPMENT TYPE COMPARED TO DATA TYPE REQUESTS (Continued)

Total Requested		Procurement Specifications	%	Comparative Testing	%	Tactical Use Data	%	Training Material	%	Cost Data	%
Clothing:											
1ST	5	4	(80.0)	3	(60.0)	3	(60.0)	1	(20.0)	3	(60.0)
2ND	5	3	(60.0)	4	(80.0)	4	(80.0)	3	(60.0)	3	(60.0)
3RD	16	13	(81.3)	11	(68.8)	6	(37.5)	5	(31.3)	15	(93.8)
4TH	11	4	(36.4)	8	(72.7)	9	(81.8)	6	(54.5)	6	(54.5)
5TH	25	18	(72.0)	19	(76.0)	10	(76.0)	18	(72.0)	19	(76.0)
	60	42	(70.0)	45	(75.0)	41	(68.3)	33	(55.0)	46	(76.7)
Other:											
1ST	3	2	(66.7)	2	(66.7)	2	(66.7)	1	(33.3)	1	(33.3)
2ND	1	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
3RD	2	1	(50.0)	1	(50.0)	1	(50.0)	1	(50.0)	1	(50.0)
4TH	1	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
5TH	4	2	(50.0)	3	(75.0)	2	(50.0)	3	(75.0)	3	(50.0)
	11	5	(45.5)	6	(54.5)	5	(45.5)	5	(45.5)	4	(36.4)

Figure 11
FIRST FIVE CHOICES FOR EACH EQUIPMENT TYPE COMPARED TO DATA TYPE REQUESTS (Continued)

Region	Equipment
New England	(1) Handguns, (2) Bombs, (3) Aerosol Irritant Projectors
Middle Atlantic	(1) Handguns, (2) Body Armor (3) Aerosol Irritant Projectors
East North Central	(1) Handguns, (2) Bombs, (3) Body Armor
West South Central	(1) Handguns, (2) Bombs, (3) Aerosol Irritant Projector
West North Central	(1) Bombs, (2) Handguns, (3) Shotguns
South Atlantic	(1) Handguns, (2) Aerosol Irritant Projectors, (3) Bombs
East South Central	(1) Aerosol Irritant Projectors, (2) Bombs, (3) Rifles
Pacific	(1) Handguns, (2) Bombs, (3) Aerosol Irritant Projectors
Mountain	(1) Handguns, (2) Ammunition, (3) Bombs

Figure 12
TOP THREE EQUIPMENT CHOICES, FIRST PRIORITY, BY REGION

Region	Equipment
New England	(1) Training, (2) Tactical Use, (3) Comparative Testing
Middle Atlantic	(1) Training, (2) Tactical Use, (3) Comparative Testing
East North Central	(1) Tactical Use, (2) Training, (3) Comparative Testing
West South Central	(1) Training, (2) Comparative Testing, (3) Tactical Use
West North Central	(1) Training, (2) Tactical Use, (3) Comparative Testing
South Atlantic	(1) Training, (2) Tactical Use, (3) Comparative Testing
East South Central	(1) Training, (2) Tactical Use, (3) Cost Data
Pacific	(1) Comparative Testing, (2) Training, (3) Tactical Use
Mountain	(1) Training, (2) Tactical Use, (3) Comparative Testing

Figure 13
TOP THREE DATA CHOICES, FIRST PRIORITY, BY REGION

Rank Priority/Type of Equipment

Based on the total number of times a particular equipment type category has been checked as one of the top five informational needs, a system of ranking can be established. To effect such a system that will make more clear the relative significance of informational needs in each category, weights will arbitrarily be assigned. For example, each time an individual equipment type is checked by a police department as the category in which information is most needed, it will be given a weight of five. Similarly, items cited as pertaining to the second priority level will receive a weight of four, third priority weapons a three, fourth a two and fifth, a one. It should be noted, however, that this procedure does not imply that a first priority item chosen is five times as important as a fifth choice priority level, as this is not a measure of the intensity of need but rather a convenient method of ranking by priority weights.

As noted earlier, information on handguns was chosen 184 times. Broken down, this reveals that 113 departments cited handguns as their primary informational need, 22 placed them in the second level, 16 in the third category, 19 in the fourth and 14 placed handguns in the fifth priority level. As a result, handguns are ranked first in terms of informational needs with a weighted value of 753, i.e., (113 x 5) + (22 x 4) + (16 x 3) + (19 x 2) + (20 x 1). In similar fashion, the bombs category is

Equipment	Population Category				
	250,000 & Over	100,000-249,999	50,000-99,999	25,000-49,999	Under 25,000
Handguns	3	3	2	1	1
Bombs	2	1	1	6	3
Body Armor	1	2	4	4	5
Aerosol Irritant Projectors	5	6	4	2	4
Shotguns	7	7	6	3	2
Ammunition	6	9	3	4	6
Incendiary Devices	4	3	8	7	9
Masks	8	5	10	10	
Automatic Weapons	9	10	10	9	7
Grenades			7	8	9
Some Other	10	8	9		8

Figure 14
FIRST TEN EQUIPMENT CHOICES ACCORDING TO POPULATION GROUPS

given a weight of 589 and is placed second, next to handguns, as that equipment type for which information is most needed by police departments in the United States. Information needs on shotguns has been determined to rank it third (527), followed by aerosol irritant projectors (470), body armor (448), ammunition (380), incendiary devices (372), automatic weapons (318), grenades (276), and rifles are placed number ten with a weighted value of 260.

The results of this exercise appear in figure 20 in which equipment types have been ordered based on their aggregate weighted score. The second column of this table shows the relative position of the score for each equipment type when compared to the greatest score—that associated with handguns. Figure 21 shows the graphical effect.

This system of weighting revealed that information on handguns seems to be more important to the responding departments than information on any other weapon or piece of equipment.

There are several factors that conceivably could account for the extent of the interest that has been expressed by the respondents in handguns:

- Handguns is certainly one of the few categorical items that is necessarily in use by all respondents, whereas, bulk dispensers or grenades may not be. With the extent of their present use acknowledged, handguns automatically have a potentially greater interest factor.

Equipment	1st	2nd	3rd	4th	5th	Total
A Handguns	14	4	3	3	2	26
B Shotguns	3	6	4	1	3	17
C Rifles	0	3	2	3	1	9
D Automatic Weapons	1	2	5	3	3	14
E Ammunition	3	6	2	3	7	21
F Aerosol Irritant Proj.	3	4	4	5	6	22
G Projectiles	2	2	2	5	1	12
H Grenades	1	4	0	0	7	12
I Bulk Dispensers	4	1	1	3	0	9
J Nightsticks	0	1	0	0	1	2
K Blackjacks, Saps	0	0	1	1	0	2
L Riot Batons	0	0	1	1	0	2
M Special Purpose Batons	0	0	1	1	0	2
N Bombs	11	6	7	4	2	30
O Military Munitions	0	2	1	4	1	8
P Incendiary Devices	4	6	6	5	2	23
Q Body Armor	8	5	6	8	6	33
R Vehicle Armor	0	2	3	2	5	12
S Masks	3	2	6	3	2	16
T Helmets	0	3	1	3	2	9
U Clothing	1	0	2	1	4	8
V Other	1	0	1	0	1	3
Total	59	59	59	59	58	294

Figure 15
EQUIPMENT PRIORITIES FOR POPULATION GROUP 250,000

Equipment	1st	2nd	3rd	4th	5th	Total
A Handguns	10	0	0	1	2	13
B Shotguns	1	6	2	1	0	10
C Rifles	0	0	4	0	1	5
D Automatic Weapons	3	1	0	3	0	7
E Ammunition	0	2	1	2	3	8
F Aerosol Irritant Proj.	0	1	3	3	4	11
G Projectiles	0	0	1	2	1	4
H Grenades	2	0	0	1	4	7
I Bulk Dispensers	1	2	0	1	0	4
J Nightsticks	0	0	0	0	0	0
K Blackjacks, Saps	0	0	1	0	0	1
L Riot Batons	1	0	0	1	0	2
M Special Purpose Batons	0	0	1	0	0	1
N Bombs	6	2	3	4	3	18
O Military Munitions	0	1	5	1	0	7
P Incendiary Devices	1	5	1	3	3	13
Q Body Armor	2	2	4	3	4	15
R Vehicle Armor	1	3	1	3	1	9
S Masks	1	5	2	1	3	12
T Helmets	0	2	2	1	1	6
U Clothing	2	0	1	1	2	6
V Other	1	0	0	0	0	1
Total	32	32	32	32	32	160

Figure 16
EQUIPMENT PRIORITIES FOR POPULATION GROUP — 100,000-249,999

Equipment	1st	2nd	3rd	4th	5th	Total
A Handguns	17	2	3	5	2	29
B Shotguns	4	13	5	3	1	26
C Rifles	1	5	5	2	1	14
D Automatic Weapons	4	1	3	4	2	14
E Ammunition	4	6	5	5	8	28
F Aerosol Irritant Proj.	4	8	8	5	2	27
G Projectiles	2	1	5	3	2	13
H Grenades	3	4	3	5	7	22
I Bulk Dispensers	2	2	3	3	8	18
J Nightsticks	0	1	1	1	1	4
K Blackjacks, Saps	0	0	0	1	1	2
L Riot Batons	1	1	1	1	1	5
M Special Purpose Batons	0	0	0	0	2	2
N Bombs	12	5	4	6	3	6
O Military Munitions	0	1	3	2	0	6
P Incendiary Devices	1	10	1	5	4	21
Q Body Armor	7	4	3	8	5	27
R Vehicle Armor	2	1	2	2	5	12
S Masks	2	2	2	5	3	14
T Helmets	1	1	4	1	4	11
U Clothing	1	0	6	0	5	12
V Other	1	0	1	1	0	3
Total	69	68	68	68	67	340

Figure 17
EQUIPMENT PRIORITIES FOR POPULATION GROUP 50,000 — 99,999

Equipment	1st	2nd	3rd	4th	5th	Total
A Handguns	24	7	4	6	2	43
B Shotguns	6	14	8	3	6	37
C Rifles	3	1	8	6	3	21
D Automatic Weapons	6	12	6	3	0	27
E Ammunition	11	8	2	6	9	36
F Aerosol Irritant Proj.	10	8	8	7	8	41
G Projectiles	3	7	6	3	2	21
H Grenades	3	7	3	10	5	28
I Bulk Dispensers	0	2	5	3	4	14
J Nightsticks	3	0	2	4	3	12
K Blackjacks, Saps	0	1	0	0	1	2
L Riot Batons	3	0	3	2	3	11
M Special Purpose Batons	0	0	1	1	1	3
N Bombs	11	5	9	4	3	32
O Military Munitions	0	2	1	3	5	11
P Incendiary Devices	4	11	7	4	4	30
Q Body Armor	5	3	6	12	10	36
R Vehicle Armor	0	2	2	2	2	8
S Masks	2	2	5	5	7	21
T Helmets	0	1	4	3	5	13
U Clothing	0	0	3	5	7	15
V Other	0	0	0	0	2	2
Total	94	93	93	92	92	464

Figure 18
EQUIPMENT PRIORITIES FOR POPULATION GROUP 25,000 — 49,999

Equipment	1st	2nd	3rd	4th	5th	Total
A Handguns	47	7	4	4	6	68
B Shotguns	8	31	9	6	3	57
C Rifles	2	9	14	10	4	39
D Automatic Weapons	6	3	12	12	7	40
E Ammunition	4	6	12	4	15	41
F Aerosol Irritant Proj.	13	10	12	12	5	52
G Projectiles	1	5	4	7	10	27
H Grenades	4	4	7	12	7	34
I Bulk Dispensers	2	2	2	8	2	16
J Nightsticks	0	1	1	4	5	11
K Blackjacks, Saps	0	0	0	0	1	1
L Riot Batons	0	5	4	7	2	18
M Special Purpose Batons	0	0	2	2	0	4
N Bombs	25	8	6	7	7	53
O Military Munitions	0	2	3	1	4	10
P Incendiary Devices	1	14	7	4	8	34
Q Body Armor	8	9	10	8	9	44
R Vehicle Armor	1	1	6	7	3	18
S Masks	1	3	5	5	8	22
T Helmets	5	3	5	2	12	27
U Clothing	1	5	4	4	7	21
V Other	0	1	0	0	1	2
Total	129	129	129	126	126	639

Figure 19
EQUIPMENT PRIORITIES FOR POPULATION GROUP UNDER 25,000

Equipment	Weighted Total	Relative Position
1. Handguns	753	1.00
2. Bombs	589	.78
3. Shotguns	527	.70
4. Aerosol Irritant Projector	470	.62
5. Body Armor	448	.59
6. Ammunition	380	.50
7. Incendiary Devices	372	.49
8. Automatic Weapons	318	.42
9. Grenades	276	.37
10. Rifles	260	.35
11. Masks	222	.29
12. Projectiles	197	.26
13. Bulk Dispensers	164	.22
14. Helmets	162	.22
15. Vehicle Armor	150	.20
16. Clothing	140	.19
17. Military Munitions	107	.14
18. Riot Batons	106	.14
19. Nightsticks	69	.09
20. Other	31	.04
21. Special Purpose Batons	28	.04
22. Blackjacks, Saps	17	.02

Figure 20
WEIGHTED RANKING OF EQUIPMENT TYPES

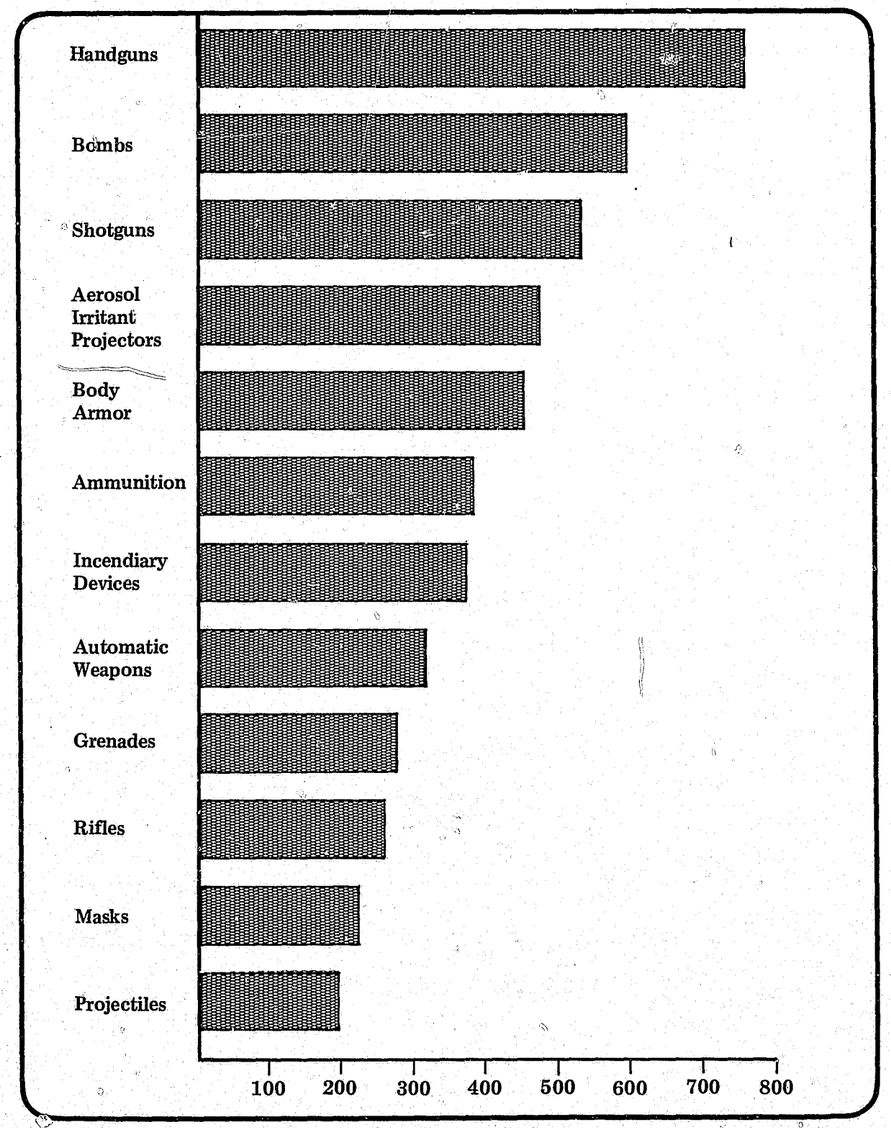

Figure 21
TOP TWELVE WEIGHTED CHOICES

- While other weapons listed (e.g. nightsticks) may also be in common use, the information (specifically training materials) required to successfully employ them may be minimal.

- Handguns are a much more flexible weapon useable in varied circumstances where related weapons (e.g. shotguns, rifles, automatic weapons) are not.

The demand for information may totally be due to different reasons from equipment type to equipment type. With regard to bombs, which we have ranked second, the information demand may be a function of time and contemporary circumstances. Five years ago, information needs on bombs were slight indeed. It very well might be that a surge of interest in bombs is directly related to the exponential increase in the United States in the use of bombs as a means of political action in the recent past. Other examples can be cited for interest in other equipment categories.

Rank Priority/Type of Data

Treating the type of data in which departments have shown interest in a similar manner, we find that training materials are once again considered to be most important in terms of priority as well as aggregate responses. In figure 22 the number of requests with respect to each type of data is shown in relation to the assigned priorities.

Data Type	1st	2nd	3rd	4th	5th	Total
Procurement Specifications	188	172	203	194	214	971
Comparative Testing	245	224	249	236	252	1,206
Tactical Use Data	260	263	273	269	256	1,321
Training Material	275	317	278	266	284	1,420
Cost Data	201	200	217	199	217	1,034
Total	1,169	1,176	1,220	1,164	1,223	5,952

Figure 22
FREQUENCY OF REQUESTS FOR DATA TYPES

Weighting these observations on the inverse scale ranging from 1–5 we find the following:

	Ranking Data Types	Weighted Total	Relative Position
1.	Training Material	4,271	1.00
2.	Tactical Use Data	3,965	.93
3.	Comparative Testing	3,592	.85
4.	Cost Data	3,071	.72
5.	Procurement Specifications	2,839	.66

Figure 23
WEIGHTED RANKING OF DATA TYPES

This is shown graphically in figure 24.

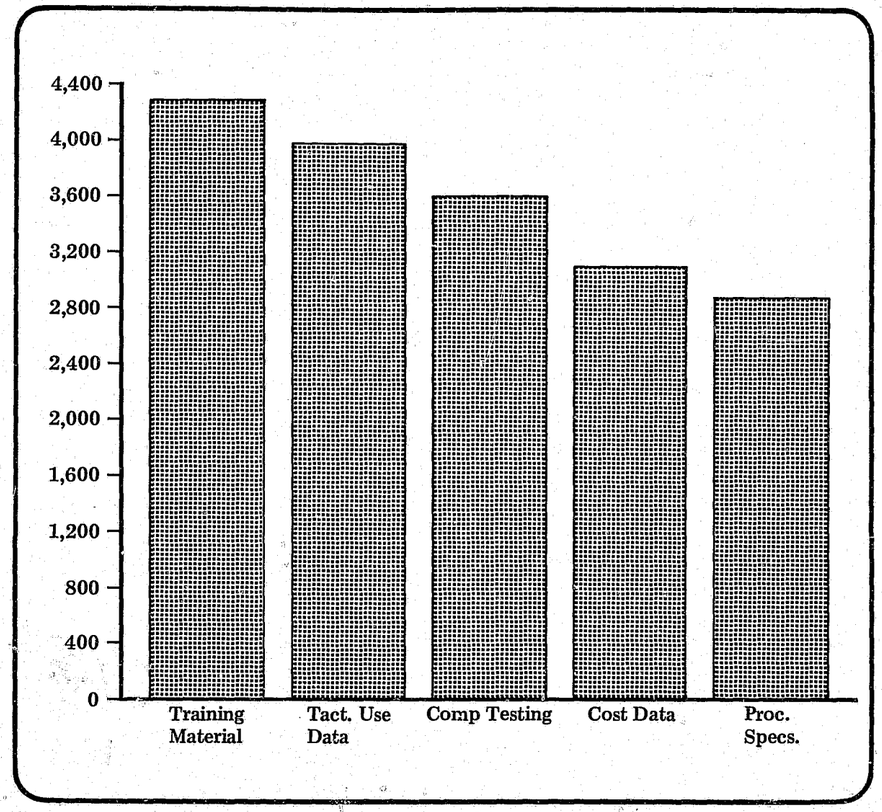

Figure 24
FIRST FIVE RANKED DATA TYPES

Rank Priority/Population Groups

In figures 15-19 equipment selections for each population group were presented with respect to the five priorities. By applying the weights to this data, the information contained in figure 25 below results.

Note that by applying weights, the earlier observations on page 24 must be somewhat qualified.

- Interest in bomb data is still lowest in the population group 25,000 – 29,999. Moreover, interest in bomb data does seem to some extent dependent on the size of the jurisdiction in

Population Group 250,000 +		
Equipment	**Weighted Total**	**Relative Position**
1. Bombs	110	1.00
2. Handguns	103	.94
3. Body Armor	86	.78
4. Incendiary Devices	74	.67
5. Aerosol Irritant Proj.	59	.54
6. Ammunition	58	.53
7. Shotguns	56	.51
8. Masks	49	.45
9. Automatic Weapons	37	.34
10. Projectiles	35	.32
11. Bulk Dispensers	33	.30
12. Grenades	28	.25

Population Group 100,000 – 249,999		
Equipment	**Weighted Total**	**Relative Position**
1. Bombs	58	1.00
2. Handguns	54	.93
3. Body Armor	40	.69
4. Shotguns	38	.66
5. Incendiary Devices	37	.64
6. Masks	36	.62
7. Vehicle Armor	27	.47
8. Automatic Weapons	25	.43
9. Aerosol Irritant Proj.	23	.40
10. Helmets	17	.29
10. Clothing	17	.29
10. Ammunition	17	.29

Population Group 50,000 – 99,999		
Equipment	**Weighted Total**	**Relative Position**
1. Handguns	114	1.00
2. Bombs	107	.94
3. Shotguns	94	.82
4. Aerosol Irritant Proj.	88	.77

Figure 25
WEIGHTED RANKING OF EQUIPMENT BY POPULATION GROUP

Population Group 50,000 – 99,999 (continued)		
Epuipment	**Weighted Total**	**Relative Position**
5. Body Armor	81	.71
6. Ammunition	77	.68
7. Incendiary Devices	62	.54
8. Grenades	54	.47
9. Rifles	45	.39
10. Automatic Weapons	43	.38
11. Bulk Dispensers	41	.36
12. Projectiles	37	.32

Population Group 25,000 – 49,999		
Equipment	**Weighted Total**	**Relative Position**
1. Handguns	174	1.00
2. Aerosol Irritant Proj.	128	.74
3. Shotguns	122	.70
4. Ammunition	114	.66
4. Bombs	114	.66
5. Automatic Weapons	102	.59
6. Incendiary Devices	97	.56
7. Body Armor	89	.51
8. Grenades	77	.44
9. Projectiles	69	.40
10. Rifles	58	.33
11. Masks	50	.29

Population Group Under 25,000		
Equipment	**Weighted Total**	**Relative Position**
1. Handguns	289	1.00
2. Shotguns	206	.71
3. Bombs	196	.68
4. Aerosol Irritant Proj.	170	.59
5. Body Armor	131	.45
6. Rifles	112	.39
7. Automatic Weapons	109	.38
8. Ammunition	103	.36
9. Incendiary Devices	98	.34
10. Grenades	88	.30
11. Helmets	68	.24
12. Projectiles	61	.21

Figure 25
WEIGHTED RANKING OF EQUIPMENT BY POPULATION GROUP (Continued)

that departments in jurisdictions with large populations have a much higher interest than departments in smaller jurisdictions.

- Interest in shotguns is still highly dependent on population so that interest increases as the population of the jurisdiction decreases.
- Interest in ammunition no longer seems population dependent.
- Interest in masks is still highest in jurisdictions ranging in population from 100,000 – 249,999.

There are a number of important points contained in figure 26. First, note that all types of information concerning handguns appears in the table, reinforcing the importance of this weapon in police work. Further, note that bombs, while ranking second in importance, are represented by only two types of data: training and tactical use. Obviously in this case training implies detection and dismantling, while tactical use implies targets and motives in bomb placements.

More importantly, however, all of the weapons and most of the data types seem to have a direct association with the handling of militant political activities characterized by mob activity and bombings. This point while noted can hardly be said to be conclusive solely on the basis of the available data since departmental motivations were not directly solicited.

Total Priority

Independently examining the priorities associated with equipment and data types while useful, does not show their total impact when both are considered in conjunction with each other. Because

Equipment/Data Type	Weighted Total	Relative Position
1. Handguns/Training	396	1.00
2. Handguns/Comparative Testing	349	.88
3. Bombs/Training	343	.87
4. Handguns/Tactical Use	330	.87
5. Shotguns/Training	290	.73
6. Aerosol Irritant Proj./Training	266	.67
7. Shotguns/Tactical Use	263	.66
8. Aerosol Irritant Proj./Tactical Use	262	.66
9. Aerosol Irritant Proj./Comparative Testing	243	.61
10. Bombs/Tactical Use	240	.59
11. Handguns/Cost Data	234	.59
12. Handguns/Procurement Specifications	228	.58

Figure 26
WEIGHTED RANKING OF EQUIPMENT/DATA TYPE

handguns are most important when compared to other equipment and training material most important when compared to other types of data, this does not necessarily mean that training material on handguns is the most important combination of equipment and data types. (Although in fact, it is.)

As there are 22 categories of equipment and 5 categories of data, a total of 110 combinations of the two are possible. In addition, each combination has an aggregate weighted score (based on the weights ranging from 1-5) associated with it denoting the importance of the combination.[3] In figure 26, the 12 most important combinations of equipment and data type are displayed. These combinations may be said to represent the most important 10 percent of the data needs for the surveyed departments. This same data is presented graphically in figure 27.

CURRENT EQUIPMENT

The second section of the "Police Weapons Survey" deals with, as noted earlier, an effort to collect and evaluate national data on the current usage of weapons and protective equipment. Each of the twelve equipment item categories evaluated was broken down to identify the manufacturer or brand; the model or identifying data; the caliber, size or gauge; and the approximate number of the item each force has in use or on hand. Each item has been analyzed with the results indicating what are currently the more popular police weapons and protective equipment.

Handguns

Beginning with handguns, which is the first listed weapon on the survey form, it is immediately apparent that Colt and Smith & Wesson are by far the most popular brands, and the .38 special is the model in greatest use. Significantly, 89 percent of the responding departments use these brands and this particular caliber handgun. In the 25,000 and over population group, approximately 93 percent of the handguns in use were of these makes and this caliber. Further, while departments did note models and calibers other than the .38 special, only one of the respondents noted use of a handgun manufactured by anyone other than Smith & Wesson or Colt. Among the other models cited were: the Smith & Wesson Model .357, Smith & Wesson 9 mm Model 39, Smith & Wesson Model 58 .41 magnum, Colt Mark III .357, and the Colt Government Model .45.

Shotguns

There were many shotgun manufacturers listed with varied models. However, only rarely was other than the 12-gauge model in use. Here it should be also noted that while there is undisputed leadership in the brand and model in greatest use, there is no gap as there was with handguns. Certainly the most popular shotgun is the Remington Model 870 12 gauge. This is the case both in terms of the number on hand and the number of departments that, at least to some degree, rely on it. Nearly 45 percent of the shotguns maintained by the respondents were of this make and model. Next in popularity is the Ithaca Model 37, followed by the Winchester Model 12. With rare

[3]Conceptually, a three dimensional array with vectors (equipment type, data type, and weighting) exists with a total of 560 cells.

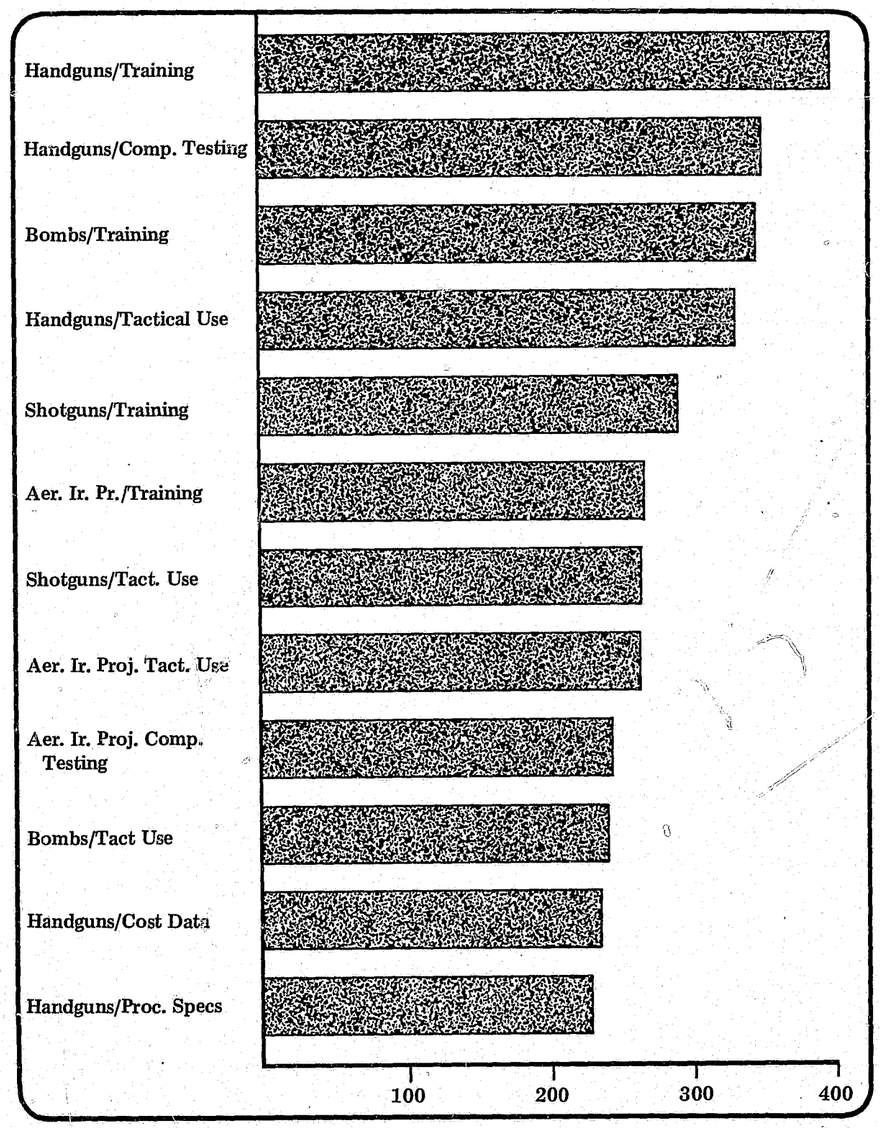

Figure 27
COMPARISON OF THE TWELVE MOST IMPORTANT COMBINATIONS OF EQUIPMENT AND DATA TYPES

exception, all shotguns reported were made by either Remington (55 percent), Winchester (21 percent), Ithaca (13 percent), or Hi-Standard (5 percent).

Rifles

The third category of section two deals with the brand, model and caliber of rifles in current use by the respondents' forces. The results here are contrary to those obtained in the handgun and shotgun sections above, as no one particular make or model is absolutely predominant. The weapon most frequently mentioned, however, is the .30 caliber U.S. M1 carbine. Approximately 27 percent of the rifles possessed by the responding departments are of this type. While there were many models under each manufacturer heading, overall, Winchester is the leading producer; just over 33 percent of the reported rifles were made by Winchester. The .30 caliber Winchester Model 94 evolved as the most popular model within this make. Meanwhile, Remington produced almost 12 percent of the total rifles on hand with the Models 700 and 760 being nearly equally popular.

Automatic Weapons

In the automatic weapons grouping, Thompson submachine guns were the most popular make among the responding police departments. All Thompsons were .45 caliber. The models most frequently mentioned were the 1921 and 1928. Approximately 40 percent of the automatic weapons maintained by the participating police departments are of this type. The second most frequently mentioned brand is the Harrington & Richardson Reising. Here, the Model 50 .45 caliber is the most popular. Among the others in this category are the M2 .30 caliber carbine, the Smith & Wesson Model 76 9mm submachine gun, and the Ingram Model 6 .45 caliber submachine gun.

Aerosol Irritant Projectors

The General Ordinance Equipment Company (GOEC) appears to be the most popular manufacturer of "Mace"-type aerosol irritant chemical projectors. Over 60 percent of the projectors held by the respondents are made by GOEC. Within this subcategory, the model Mark IV is the absolute favorite. By itself, this model represents nearly 53 percent of all projectors. Federal Laboratories is the second largest supplier with one-quarter of the market. Its models 280 and 282 alone represent 21 percent of this market. Other manufacturers of aerosol irritant projectors included Del-Defend (Dow Chemical Company), and Penguin.

Chemical Grenades

Meanwhile, Federal Laboratories and Lake Erie Chemical Company are nearly the exclusive suppliers of the respondents' chemical grenades. Federal, it appears, maintains a slight lead over Lake Erie in this area. The most popular model made by Federal is the 112, followed by the 121 and various other CN and CS model numbers. CS-types are the most popular models produced by Lake Erie.

Chemical Projectiles

In the related category of chemical projectiles, Lake Erie and Federal again account for by far the largest proportion of reported projectiles. Here again, Federal appeared to be the more popular of the two producers, although the gap favoring Federal is larger than was the case in chemical grenades. The Federal models favored most were the 230 Flite-Rite CN, 206 Spedeheat CN, and the 203 Short Range CN. The popular Lake Erie models include various long and short range and barricade models. All were of the 37-38 mm size.

Nightsticks

Where the number of producers standing out in the market for the above mentioned weapons categories was limited, this is not the case with regard to nightsticks. The type, size and manufacture of the respondents' nightsticks is varied, with many being custom-made and individually owned. Given the latter factor of ownership by individual policemen, many departments were incapable of offering precise data. Nevertheless, from what information was supplied, generalizations will be attempted. If one particular manufacturer, size, and model were to be ascribed as the most popular, it would probably have to be the Monadnock 26-inch plastic model. As has been noted, the number of producers here is large, and because the leader's favorite model is one composed of plastic does not mean that most nightsticks currently in use are of this substance. The opposite seems to be the case, as so many of the other producers make wood batons and a large number of the nightsticks in use are older than plastic itself. Hickory appeared to be at least equally as popular as plastic. The sizes ranged from 12 to 30 inches. Among the long list of suppliers of nightsticks are Kohaut, Federal, Central Equipment of Massachusetts, Hercules, and George F. Cake. Again, many of the weapons in this category are custom-made.

Riot Batons

In terms of riot batons, the number of producers again is large. The Kohaut 36-inch model has been expressed as the most widely used. Two other popular producers are Monadnock and Federal. The sizes varied from 18 to 40 inches.

Body Armor

Body armor is a category in which the evidence cited is inconclusive since there are so many producers and varied types of equipment made by each manufacturer. Further, just over 50 percent of the respondents stated that their forces possessed some form of body armor. The varied types of armor equipment cited included fragment proof vests and flak jackets, transparent plastic shields, chap-type leg protectors, full body-type armor, etc. Here, the companies mentioned were Federal Laboratories, Davis Aircraft, Defensor, Transcon, GOEC, and the United States Government through varied surplus outlets.

Masks and Helmets

Again, with gas masks and riot helmets, the respondents have chosen their equipment from a large group of manufacturers. In the gas mask category, Federal Laboratories appears to be the most popular brand. Others include M.S.A. Company, Penguin, Lake Erie and Wilson. The American Optical Company was the company most frequently mentioned as the maker of riot helmets. The most favored models American Optical produces, according to the respondents, are Sure-Guard and Dura-Guard. Other varieties of riot helmets are made by Buco, Bell, Smith & Wesson, and E.D. Bullard Company.

APPENDIX

SELECTED LAW ENFORCEMENT EQUIPMENT INDEX

This list of currently available police equipment supplements the information gained from the survey. Under each of the twelve equipment categories cited in the survey are listed the specific weapons or pieces of equipment commonly used by law enforcement agencies in the United States. All materials are identified by name and model. Further information on specific items of equipment can be obtained by contacting the manufacturer or supplier at the address indicated for each product.

I. Firearms

A. Handguns: U.S. Made

1. Browning Arms Company
Rt. 4, Box 624-B
Arnold, Missouri 63010
a. "Hi-Power" automatic, 9mm

2. Charter Arms Corporation
265 Asylum Street
Bridgeport, Connecticut
a. "Undercover" DA revolver, .38 special

3. Colt Industries
150 Huyshope Avenue
Hartford, Connecticut 06102
a. Double action revolvers
1. "Agent" .38 special
2. "Cobra" .38 special
3. "Detective Special" .38 special
4. "Diamondback" .38 special
5. "Lawman MK III" .357
6. "Metropolitan MK III" .38 special
7. "Official Police MK III" .38 special
8. "Police Positive" .38 special
9. "Officers Model Match" .38 special
10. "Python" .356
11. "Trooper MK III" .357, .38 special
b. Single action revolvers
1. "Single Action Army" .357, .45 L. Colt
c. Automatics
1. "Commander" .38 super, .45 a.c.p., 9mm
2. "Gold Cup National Match," .38 special wad cutter

3. "Gold Cup National Match MK IV," .45 a.c.p. mid-range
4. "Government Model MK IV," .45 a.c.p.
5. "Super .38," .38 super

4. Dan Wesson Arms
293 So. Main Street
Monson, Massachusetts 01057
a. "Model W12" DA revolver, .357, .38 special
b. "Model D11" DA revolver, .357, .38 special

5. Harrington & Richardson, Inc.
Industrial Rowe
Gardner, Massachusetts 01442
a. "Model 925 Defender," DA revolver, .38 S&W

6. Iver Johnson Arms & Cycle Works
Fitchburg, Massachusetts 01420
a. "Model 675 Viking Snub" DA revolver, .38 S&W

7. Smith & Wesson, Inc.
Springfield, Massachusetts 01101
a. Double action revolvers
1. "Model No. 29 .44 Magnum"
2. "Model No. 57 .41 Magnum"
3. "Model No. 58 .41 Military & Police," .41 magnum
4. "Model No. 27 .357 Magnum"
5. "Model No. 28 Highway Patrolman," .357
6. "Model No. 19 .357 Combat Magnum," .357
7. "Model No. 25 1955 .45 Target," .357
8. "Model No. 10 .38 Military & Police," .38 special
9. "Model No. 12 .38 M&P Airweight," .38 special
10. "Model No. 15 .38 Combat Masterpiece," .38 special
11. "Model No. 14 K-38 Masterpiece," .38 special
12. "Model No. 33 .38 Regulation Police," .38 S&W
13. "Model No. 36 .38 Chiefs Special," .38 special
14. "Model No. 60 .38 Chiefs Special Stainless," .38 special
15. "Model No. 38 Bodyguard Airweight," .38 special
16. "Model No. 40 Centennial," .38 special
17. "Model No. 32 Terrier," .38 S&W
b. Automatics
1. "Model No. 39 Double Action Automatic," 9 mm
2. "Model No. 52 .38 Master," .38 special wad cutter

8. Sturm, Ruger & Company, Inc.
Southport, Connecticut 06490
a. Double action revolvers
1. "Security Six," .357, .38 special
b. Single action revolvers
1. "Blackhawk," .30 carbine, .357, 9mm, .41 magnum, .44 magnum

9. Universal Firearms Corporation
   3746 E. 10th Ct.
   Hialeah, Florida 33013
   a. "Enforcer Auto Carbine," .30 carbine

B. Shotguns: U.S. Made

1. Browning Arms Company
   Rt. 4, Box 624-B
   Arnold, Missouri 63010
   a. "Automatic-5 Buck-Special," 12 gauge

2. High-Standard Manufacturing Company
   1817 Dixwell Avenue
   Hamden, Connecticut 06514
   a. "Model 8111" pump, 12 gauge
   b. "Model 8113" pump, 12 gauge
   c. "Model 10 Series B" semiautomatic, 12 gauge

3. Holland Firearms, Inc.
   P.O. Box 55066
   Houston, Texas 77055
   a. "Auto-Burglar" double-barrel, 20 gauge

4. Ithaca Gun Company, Inc.
   123 Lake Street
   Ithaca, New York 14850
   a. "Model 37" pump, 12 gauge

5. O. F. Mossberg & Sons, Inc.
   7 Grasso St.
   New Haven, Connecticut 06473
   a. "Model 500" pump, 12 gauge

6. Remington Arms Company
   Bridgeport, Connecticut 06602
   a. "Model 870" pump, 12 gauge

7. Savage Arms Corporation
   Westfield, Massachusetts 01085
   a. Savage "Model 69 R-H" pump, 12 gauge
   b. Stevens "Model 311" double-barrel, 12 gauge

8. Winchester Repeating Arms Company
   New Haven, Connecticut 06504
   a. "Model 1200" pump, 12 gauge

C. Rifles: U.S. Made

1. ArmaLite, Inc.
   118 East 16th Street
   Costa Mesa, California
   a. "AR-180" semiautomatic, .223

2. Colt Industries
   150 Huyshope Avenue
   Hartford, Connecticut 06102
   a. "AR-15 Model R-6000" semiautomatic (rifle), .223
   b. "AR-15 Model 6001" semiautomatic (carbine), .223

3. J&R Engineering
   1857 Merced
   El Monte, California
   a. "M-68 Carbine," 9mm
   b. "M-80 Carbine," 9mm

4. Military Armament Corporation
   Powder Springs, Georgia 30073
   a. "Countersniper Rifle System," .223, .308

5. Plainfield Machine Company, Inc.
   Box 281
   Dunellen, New Jersey 08812
   a. "Plainfield Carbine," .30 carbine

6. Remington Arms Company
   Bridgeport, Connecticut 06602
   a. "Model 700," .222, .308, .30-06 carbine

7. Universal Firearms Corporation
   3746 E. 10th Ct.
   Hialeah, Florida 33013
   a. "Model 1000 Autoloading Carbine," .30 carbine, .256 Winchester magnum
   b. "Model 1020 Teflon Carbine," .30 carbine, .256 Winchester magnum

8. Winchester Repeating Arms Company
   New Haven, Connecticut 06504
   a. "Model 70," .222, .308, .30-06

D. Automatic Weapons

1. ArmaLite, Inc.
   118 East 16th Street
   Costa Mesa, California
   a. "AR-18" automatic rifle, .223

2. Colt Industries
150 Huyshope Avenue
Hartford, Connecticut 06102
a. "AR-15 (M16)" automatic rifle, .223

3. Interarms
10 Prince Street
Alexandria, Virginia
a. "Walther MPK" submachine gun, 9mm
b. "Israeli (I.M.I.) Uzi" submachine gun, 9mm

4. Military Armament Corporation
Powder Springs, Georgia 30073
a. "Ingram Model 10" submachine gun, 9MM, .45 A.C.P.
b. "Ingram Model 11" submachine gun, .380 A.C.P.

5. Numrich Arms Corporation
West Hurley, New York
a. "Thompson 1928A1" submachine gun, .45 A.C.P.

6. Security Arms Company
Suite 1004
1815 North Ft. Myer Drive
Arlington, Virginia 22209
a. "Heckler & Koch MP5" submachine gun, 9mm

7. Smith & Wesson, Inc.
Springfield, Massachusetts 01101
a. "Model 76" submachine gun, 9mm

II. Chemical Weapons

A. Aerosol Irritant Projectors

1. General Ordnance Equipment Corporation
Box 11211 Freeport Road
Pittsburgh, Pennsylvania 15238
a. Mark V Mace
b. Mark IV Mace
c. Mark II Miniature Mace
d. Mark VII Chemical Baton
e. Mark IX Chemical Mace

2. Federal Laboratories
Saltsburg, Pennsylvania 15681
a. 280 Streamer, Liquid Tear Gas Repeater
b. 282 Mini-streamer Liquid CN Repeater

3. Penguin Industries, Inc.
P.O. Box 97
Parkesburg, Pennsylvania 19365
a. Item No. AP-18
b. Item No. AP-19

4. Middle West Marketing, Inc.
216 - 226 So. Hayne Street
Chicago, Illinois 60612
a. 118cc Weapon
b. 28cc Weapon

B. Projectiles

1. A.A.I. (Aircraft Armaments, Inc.)
P.O. Box 6767
Baltimore, Maryland 21204
a. 1 - SGS - 100 Barricade Projectile (Ferret)

2. Federal Laboratories
Saltsburg, Pennsylvania 15681
a. Projectile (CN)
b. Federal Mark 200 Projectile (No. 507)
c. Federal Mark 70 Projectile (CS)
d. Federal Mark 70 Projectile (CN)
e. Federal Impact Flite-Rite Projectile (CN) (No. 232)
f. Federal Impact Flite-Rite Projectile (CS)
g. Federal Short Range Shell (CS)
h. Federal Short Range Shell (CN)
i. Federal Flite-Rite Projectile (CN) (No. 230)
j. Federal Flite-Rite Projectile (CS)
k. Federal Spedeheat Projectile (CN)
l. Federal Spedeheat Projectile (CS)
m. Federal Spedeheat Projectile (Short Range) CN (No. 219)
n. Federal Spedeheat Projectile (Short Range) CS

3. Lake Erie Chemical Division, Smith & Wesson
Rock Creek, Ohio 44084
a. Lake Erie Short Range Shell, No. 21 (CN)
b. Lake Erie Short Range Shell, No. 21 (CS)
c. Lake Erie Tru-Flite Barricade Projectile (CN)
d. Lake Erie Tru-Flite Barricade Projectile (CS)
e. Long Range Instantaneous Discharge Projectile (CN)
f. Long Range Instantaneous Discharge Projectile (CS)

4. Penguin Industries, Inc.
P.O. Box 97
Parkesburg, Pennsylvania 19365
   a. Penguin Long Range Cartridge (CN)
   b. Penguin Long Range Cartridge (CS)
   c. Penguin Barricade Penetrating Cartridge (CS)

C. Grenades

1. A.A.I.
P.O. Box 6767
Baltimore, Maryland 21204
   a. A.A.I. Multipurpose Grenade MPG 100 (CN)
   b. A.A.I. Multipurpose Grenade MPG 120 (CS)

2. Federal Laboratories
Saltsburg, Pennsylvania 15681
   a. Federal Blast Dispension Grenade (No. 121 - CN)
   b. Federal Blast Dispension Grenade (No. 514 - CS)
   c. Federal Disintegrating Grenade (No. 120 - CN)
   d. Federal Disintegrating Grenade (No. 5 - CS)
   e. Federal Triple Chaser Grenade (No. 515 - CS)
   f. Federal Triple Chaser Grenade (No. 115 - CN)
   g. Federal Spedeheat Grenade (No. 555 - CS)
   h. Federal Spedeheat Grenade (No. 112 - CN)
   i. Federal 109 Pocket Grenade (No. 109 - CS)
   j. Federal 109 Pocket Grenade (No. 109 - CN)

3. Lake Erie Chemical Division, Smith & Wesson
Rock Creek, Ohio 44084
   a. Lake Erie Mighty Midget (CN)
   b. Lake Erie Mighty Midget (CS)
   c. Lake Erie Jumper Repeater Grenade (CN)
   d. Lake Erie Jumper Repeater Grenade (CS)
   e. Lake Erie Mob-Master Instantaneous Discharge Grenade (CN)
   f. Lake Erie Mob-Master Instantaneous Discharge Grenade (CS)
   g. Lake Erie Instantaneous Discharge Grenade (CN)
   h. Lake Erie Instantaneous Discharge Grenade (CS)
   i. Lake Erie Continuous Discharge Grenade (CN)
   j. Lake Erie Continuous Discharge Grenade (CS)

4. Northrop - Carolina, Inc.
Box 3049
Ashville, North Carolina 28802
   a. Rubber Ball Grenade (CS)

5. Penguin Industries, Inc.
P.O. Box 97
Parkesburg, Pennsylvania 19365
   a. Penguin Burning Grenade (CN)
   b. Penguin Burning Grenade (CS)
   c. Penguin Baseball Grenade (CN)
   d. Penguin CN/Smoke Grenade (CN)

D. Bulk Dispensers

1. Federal Laboratories
Saltsburg, Pennsylvania 15681
   a. Federal Jet-Fogger

2. GOEC
Box 11211 Freeport Road
Pittsburgh, Pennsylvania 15238
   a. GOEC MK XII - Pepper Fog
   b. GOEC MK XII A - Pepper Fog
   c. GOEC MK-17 - Pepper Fog

3. U.S. Army
Edgewood Arsenal
Edgewood, Maryland
   a. M5 Dispenser, Riot Control Agent, Helicopter or Vehicle Mounted
   b. M3 Dispenser, Portable, Riot Control Agent

4. P. M. Tabor & Company
Laguna Beach, California
   a. Model PTG 3
   b. Model PTG 6

5. Middle-West Marketing Corporation
Chicago, Illinois
   a. 5000 cc Weapon

III. Batons

A. Nightsticks

1. John C. Kohaut, Inc.
15 Meeker Street
West Orange, New Jersey 07052

2. Monadnock Lifetime Products, Inc.
Route 12
Fitzwilliam, New Hampshire 03447
   a. "Persuader" yawara stick, "Mon-Pac" plastic
   b. "Lightstick/Ring Grip," "Mon-Pac" plastic

3. Nobel Kogyo Company, Ltd.
   2-29, Osaki 4-Chome, Shinagawa-Ku
   Tokyo, Japan
      a. "Tokushu-Keibo, Nobel Stick" telescoping baton

B. Blackjacks, Saps

1. J. M. Bucheimer Company
   Frederick, Maryland 21701

2. Damascus Leather Shop
   Route 2, Box 573
   Boring, Oregon
      a. Palm sap and knuckle sap gloves

C. Riot Batons

1. John C. Kohaut, Inc.
   15 Meeker Street
   West Orange, New Jersey 07052
      a. 36" riot baton, hickory

2. Monadnock Lifetime Products, Inc.
   Route 12
   Fitzwilliam, New Hampshire 03447
      a. "31-30 Mob Control Stick," 31", "Mon-Pac" plastic

D. Special Purpose Devices

1. A& V Methods Company
   Special Products Division
   49 North Main Street
   Homer, New York 13045
      a. "Cumalong" flail

2. Electon Manufacturing Company, Inc.
   P.O. Box 4609
   Jacksonville, Florida 32201
      a. "Electon" electric baton

3. Martial Arts Supplies Company
   10711 Venice Boulevard
   Los Angeles, California 90034
      a. "Nunchaku" flail

4. Penguin Industries, Inc.
   P.O. Box 97
   Parkesburg, Pennsylvania 19365
      a. "Nutcracker" flail

5. Shok Baton Company
   Savage, Minnesota 55378
      a. "Shok Baton" electric baton

IV. Explosives/Disposal

A. Bomb Blanket

1. Davis Aircraft Products Company, Inc.
   Scudder & Woodbine Avenues
   Northport, Long Island, New York 11768
      a. Davis Bomb Blanket

B. Disposal Vehicle

1. Colt Industries
   150 Huyshope Avenue
   Hartford, Connecticut 06102
      a. Colt Bomb Disposal Vehicle

C. Disposal Devices

1. P. M. Tabor & Company
   Laguna Beach, California
      a. Bomb Basket

V. Protective Equipment

A. Body Armor

1. Davis Aircraft Products Company, Inc.
   Scudder and Woodbine Avenues
   Northport, Long Island, New York 11768
      a. Model 6003-1
      b. Model 6003-3
      c. Model 6003-5
      d. Model 6007-4
      e. Model 6010-2

2. Defensor Protective Equipment, Inc.
   Media, Pennsylvania
      a. Model V1-A
      b. Model V2-A

3. Federal Laboratories
   Saltsburg, Pennsylvania 15681
      a. Model P
      b. Model C
      c. Model C708F

4. General Ordnance Equipment Corporation
   Pittsburgh, Pennsylvania 15238
   a. Model 217
   b. Model 120
   c. Model 434C

5. Imperial Protector Company
   Compton, California
   a. Supershield

6. P. M. Tabor Company
   Laguna Beach, California
   a. Tabor Vest

7. Transcon Manufacturing Company
   Los Angeles, California
   a. Model 201V
   b. Model 401V

8. Skyline Industries, Inc.
   Fort Worth, Texas
   a. Skyline Vest

9. Ed Agramante, Inc.
   Yonkers, New York
   a. Lancer Vest

10. AVCO Special Materials Company
    Lowell Park, Lowell, Massachusetts
    a. Model PA-100
    b. Model PA-500

11. Carborundum Company
    Niagara Falls, New York
    a. Model KT
    b. Model AL

12. Rolls-Royce (Composite Materials)
    England
    a. Security
    b. Combat

B. Vehicle Armor

1. AVCO Special Materials Company
   Lowell Park, Lowell, Massachusetts

2. Carborundum Company
   Niagara Falls, New York

3. P. M. Tabor Company
   Laguna Beach, California

C. Protective Masks

1. Willson Products Division of
   The Electric Storage Battery Company
   Reading, Pennsylvania
   a. Model WHGW (Penguin)

2. Acme Protection Equipment Corporation
   South Avon, Michigan
   a. Model 6003 (Federal)
   b. Model 6077 (Federal)
   c. Model 6044-34 (Federal)
   d. Model 6044-3640 (Federal)
   e. All Purpose Mask, No. 6300
      Type FD (Federal)
   f. Model 6183 - Audio Command Mask (Federal)

3. Mine Safety Appliance Company
   Pittsburgh, Pennsylvania
   a. Model 66 (Lake Erie)
   b. Model 66B (Lake Erie)
   c. Model 67 (Lake Erie)
   d. Model 88184

4. Welsh Manufacturing Company
   Providence, Rhode Island
   a. Model 7683W

D. Helmets

1. Defensor Protective Equipment, Inc.
   Media, Pennsylvania 19063
   a. Model BH
   b. Model CL
   c. Model PD
   d. Model MC

2. Lake Erie Chemical Division of
   Smith & Wesson
   Rock Creek, Ohio 04484
   a. Model MK XII
   b. Model MK XV

3. Gentex Corporation
Carbondale, Pennsylvania 18407
   a. Model Rioter II
   b. Model Rioter III
   c. Model Motorcycle Police

4. Bell Toptex, Inc.
2850 East 29th Street
Long Beach, California 90806

5. Mine Safety Appliance Company
Pittsburgh, Pennsylvania 15208
   a. MSA Protector

6. American Safety Equipment Corporation
2400 Fisher Building
Detroit, Michigan 48202
   a. Model 1613
   b. Model 1612
   c. Model 1614
   d. Model 1615
   e. Model 1601
   f. Model 1602
   g. Model 1610-1

7. Penguin Industries, Inc.
P.O. Box 97
Parkesburg, Pennsylvania 19365
   a. Model CH-1

8. P. M. Tabor Company
Laguna Beach, California

9. American Sports Company, Inc.

10. Champion Helmet Industries, Inc.

11. D. S. Safety Helmet Corporation

12. Daytona Sports Company, Inc.

13. McHal Enterprises, Inc.

14. Safetech, Inc.

15. American Baseball Cap Company

16. Sharpe Audio Division of Scintrex, Inc.

17. AVCO Special Materials Company
Lowell Park, Lowell, Massachusetts
   a. Ballistic Helmet

POLICE WEAPONS CENTER PUBLICATIONS

The following publications are available upon request at no cost unless otherwise indicated.

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5-70 *Police Body Armor*
6-70 *Bomb Transport Vehicles*
7-70 *A Survey of Police Weapons Data*

REPRINT SERIES

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CHEMICAL AGENTS SERIES

Police Chemical Munitions Handbook
Police Chemical Agents Manual ($1.50)
CS Characteristics (Brochure)
CS Decontamination (Brochure)

CHEMICAL AGENTS REPRINT SERIES

Toxicology of CN, CS and DM, Directorate of Medical Research, U.S. Army
Nonlethal Chemical Agents, Joseph F. Coates
Considerations in the Use of Irritants in Law Enforcement, Richard E. Reinnagel

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- *Batons*
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- *Protective Helmets*
- *Barricade Projectiles*
- *Urban Assault Tactics*

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