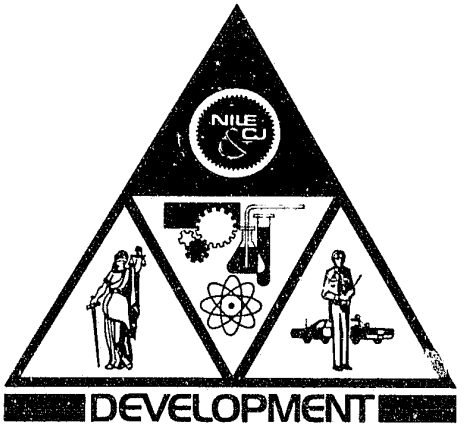
AEROSPACE REPORT No.
ATR - 77(7921)-2, Vol. III

EQUIPMENT SYSTEMS IMPROVEMENT PROGRAM

BODY ARMOR FIELD TEST AND EVALUATION FINAL REPORT

Volume III - Appendices

Law Enforcement and Telecommunications Division
September 1977



Prepared for

National Institute of Law Enforcement and Criminal Justice
LAW ENFORCEMENT ASSISTANCE ADMINISTRATION
U.S. DEPARTMENT OF JUSTICE

The Aerospace Corporation

Aerospace Report No.
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FIELD TEST AND EVALUATION
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Volume III – Appendices

Law Enforcement and Telecommunications Division
THE AEROSPACE CORPORATION
El Segundo, California

September 1977

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Contract No. J-LEAA-025-73

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EQUIPMENT SYSTEMS IMPROVEMENT PROGRAM

FINAL REPORT

BODY ARMOR FIELD TEST AND EVALUATION

VOLUME III-- APPENDICES

Approved:

Joseph Meltzer, General Manager
Law Enforcement and Telecommunications
Division

ABSTRACT

This report, in three volumes, examines the acceptability and performance of various designs of soft body armor, all utilizing Kevlar 29 as the principal ballistic material. The effects of fit, comfort, and heat containment on garment acceptance and wear are assessed. The factors that are most important in the use and specification of armor are identified.

It is found that armor containing 7 to 12 plies of protective material is optimum in terms of the likelihood of preventing fatalities or injury, based upon the statistics of confiscated weapons, FBI assault data, and the wear histories of the garments tested. Changes in attitudes of the officers wearing armor were negligible. None of the armor designs tested interfered with the officer activities, and in no case were internal injuries experienced from assaults while wearing the armor.

An area meriting further investigation is the study of blunt trauma from higher energy threats, in particular the .357 magnum and 9 mm handguns.

CONTENTS

PREFACE

This final report presents a comprehensive review of the field test and evaluation of the soft body armor developed and designed for the National Institute of Law Enforcement and Criminal Justice of LEAA, as well as various commercial armor designs of identical ballistic material. Approximately 500 garments were issued to patrol officers in 15 cities, with the test conducted during calendar year 1976. The statistical analysis and evaluation of the test data was completed in August 1977, and was supported by a subcontract to the Laboratory for Statistical and Policy Research of Boston College.

In addition to the field test and evaluation, various design modifications of the LEAA armor were implemented and tested, based upon the field test results. Studies to characterize the mechanical and ballistic properties of Kevlar 29 (the ballistic material common to all modern soft armor, and that used in the field test) from a theoretical point of view were conducted. Finally, guidelines for the specification and procurement of armor were developed. This report also provides a comprehensive review of these activities.

This report is presented in three volumes. Volume I - Executive Summary presents an overview of the field test and evaluation activities, findings and principal conclusions and recommendations. Volume II - Test and Evaluation presents a comprehensive discussion of all tests, studies, analyses, and evaluations. In addition, details are given of the test design and analytical approach, as well as a summary of three Medical-Technical Symposia held during the program, reports on all incidents, or shootings, involving armor, and the technology transfer activities carried out at the end of the program. Volume III - Appendixes includes the questionnaires used to generate the data, a Model Procurement Document, and data on later studies. The raw data used for statistical analyses are not included in Volume III because of their sheer bulk. These data will be made available to interested parties with a nominal charge for handling and mailing.

These volumes represents a follow-on to previous reports covering the design and development and pilot test phases of the Body Armor Program.

APPENDIX A

QUESTIONNAIRES

APPENDIX A. QUESTIONNAIRES

The instruments used to obtain the field test data were a series of questionnaires issued to participants by the test conductors located in each test city.

There were five sets of questionnaires designed to measure test goals and objectives which were directed at two groups of participants; a test group of volunteers to wear the garments, and a control group not issued garments to be used as a reference for detecting any change in attitudes or performance. Two sets of questionnaires (a pretest and posttest) were used to measure any changes between groups, and before and after the test period, and were distributed to each member of the test and control groups. The fifth set of questionnaires was issued each month during the test to members of the test group to detect any changes in parameter values as a function of time.

BODY ARMOR FIELD EVALUATION
PRE-TEST INTERVIEW QUESTIONNAIRE
GARMENT WEARER

Officers:

You are about to participate in an experimental program sponsored by the Law Enforcement Assistance Administration and The Aerospace Corporation. The purpose of this program is to evaluate lightweight, inconspicuous, limited protection and continuous wear body armor. As part of your participation in this program, you are requested to complete a series of questionnaires relating to the garments, your attitude toward the garments, and to provide some personal data. This is the first questionnaire in this series. The others are a monthly form and a post-test interview form. The information you provide will assist us in evaluating the performance of the garments, the impact of the garments on law enforcement personnel and changes in police officers' attitudes and performance as a result of wearing the garments. Although some of these questions may appear irrelevant, when they are statistically summarized they will provide indications of significant trends in the overall evaluation. The individual answers are not as significant as the sum total of the individual answers. Remember, there are approximately 5000 officers participating in this program in 15 cities throughout the United States.

Your cooperation in completing these questionnaires with the requested data is solicited and will be appreciated.

Thank you for your time and effort.

The National Institute of Law Enforcement and Criminal Justice and The Aerospace Corporation

INSTRUCTIONS: Please answer all questions. If a question is not applicable to you, please indicate by N.A.

1. Name (Optional) _____

   (1-5) Garment I.D. No. _____ (Mandatory)

2. *(6-7) City _____

3. (8) Sex _____ M _____ F
   1 2

4. (9-10) Age _____

5. (11-13) Height _____ Ft. _____ In. (to nearest inch)

6. (14-16) Weight _____ (to nearest five pounds)

7. (17-22) Date Garment Issued: _____
   Month/Day/Year

9. (26) Race:
   1) ____ White
   2) ____ Black
   3) ____ Latin American
   4) ____ Indian
   5) ____ Other

10. (27) Marital Status:
    1) ____ Single
    2) ____ Married

11. (28-29) Number of dependent children: _____

12. (30) **How were you selected to participate in this program?**
    1) ____ Volunteered
    2) ____ Departmental Order
    3) ____ Other (Specify)

8. Education: (Circle highest grade completed)

(23-24)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	PhD
(25)	Jr. Hi			Hi School					____ BA		____ MA				____
									1		2				3
							College				Grad School				

*Numbers in parentheses for Data Processing purposes.

WPT

13. (31) How many times have you participated in other experimental programs like this?
1) ___ None
2) ___ Once
3) ___ Twice
4) ___ Three or more times

14. (32) Would you classify your experience with experimental programs as:
1) ___ Good
2) ___ Fair
3) ___ Poor
4) ___ Not Applicable

15. (33) What is the predominant character of the area in which you work?
1) ___ Residential – Single Family
2) ___ Residential Apartments
3) ___ Commercial
4) ___ Industrial
5) ___ Mixed residential and business

16. (34) What is the predominant racial/ethnic composition of your assigned area?
1) ___ White
2) ___ Black
3) ___ Latin-American
4) ___ Other (Specify)

17. (35) How long have you been a Police Officer?
1) ___ Less than 2 years
2) ___ 2 to 5 years
3) ___ 6 to 10 years
4) ___ 11 to 15 years
5) ___ More than 15 years

18. (36) What is your present rank?
1) ___ Patrolman
2) ___ Detective
3) ___ Sgt. or Field Supervisor
4) ___ Above Sgt.

19. (37) How often do you feel in danger of assault while on duty?
1) ___ Very Often
2) ___ Often
3) ___ Occasionally
4) ___ Seldom
5) ___ Never

21. (42-43) In approximately how many of the assaults upon you did you touch the assailant before he touched you (e.g., to restrain, etc.)?
In _____ of them.

22. (44-45) In approximately how many of the assaults upon you had you issued an order to the assailant to do something in which he had refused?
In _____ of them.

23. (46-47) Approximately how many of these assaults occurred when you were alone?
In _____ of them.

24. (48-49) Approximately how many of these assaults occurred with a backup or fill unit present?
In _____ of them.

25. (50-51) In approximately how many of the assaults did the assailant attack without warning?
In _____ of them.

26. (52) How would you characterize the level of crime in your precinct?
1) ___ Very High
2) ___ High
3) ___ About Average
4) ___ Low
5) ___ Very Low

	Daily	Several times a week	Once a week	Very infrequently	Never
	(1)	(2)	(3)	(4)	(5)
27. (53)	___	___	___	___	___
28. (54)	___	___	___	___	___

27. How frequently have you worn body armor in the past?

28. While on duty how frequently do you feel a need for some type of protective armor?

20. Approximately how many times have you been assaulted in the line of duty since January 1972? (violence or threat of violence)

	Never	One time	Two times	Three times	More than three times
	(1)	(2)	(3)	(4)	(5)
(38)	___	___	___	___	___
(39)	___	___	___	___	___
(40)	___	___	___	___	___
(41)	___	___	___	___	___

(38) Handguns
(39) Shotguns and rifles
(40) Other dangerous weapons
(41) Hands, arms, fists, etc.

29. (55) **If soft body armor were made available to you personally, how much would you be willing to spend annually to acquire a vest?**
1) ___ Would not buy
2) ___ Less than $50
3) ___ $51 to $100
4) ___ $101 to $150
5) ___ $151 to $200
6) ___ Over $200
7) ___ Do not know

30. (56) **Do you think wearing soft body armor would make you more or less aggressive officer?**
1) ___ Much less
2) ___ Less
3) ___ No different
4) ___ More
5) ___ Much more

31. (57) **From the following list indicate what you feel is an acceptable level of protection for a continuous wear garment on your normal street duty assignment?**

	Protection Level	Thickness (ins.)	Weight (lbs.)
1) ___	None	-	-
2) ___	.38 special	1/8	1.5
3) ___	.45 auto	3/16	2.0
4) ___	.357 mag	1/4	3.0
5) ___	.9 mm auto	5/16	3.5
6) ___	.41 mag	3/8	4.0
7) ___	.44 mag	1/2	4.5

32.a (**) **Current Duty Assignment:**
(5-6) ___ Auto Patrol 1) ___ 1 man 2) ___ 2 man
(7-8) ___ Motorcycle 1) ___ Solo 2) ___ 3-wheel
(9) ___ Traffic
(10) ___ Detective
(11) ___ Foot Patrol
(12) ___ Tactical Unit
(13) ___ K-9
(14) ___ Other

32. (3-4) **Most frequent wear** _____ Uniform _____ Non-uniform

33. **Present Duty Hours:**
Indicate in military time to nearest hour:
(15-16) From: _____ (17-18) To: _____

(The following set of questions will be used to assess changes in attitude which may result from wearing protective garments. The responses will be compared statistically before the test and after having worn the garments. Your present answers should reflect your current attitude while on duty.)

**Data Processing Card No. 2

34. **In your contact with the public while on duty do you feel:**
(19) Relaxed:
1) ___ Very relaxed
2) ___ Somewhat relaxed
3) ___ Neutral
4) ___ Somewhat tense
5) ___ Very tense

(20) Effective in interacting with citizens:
1) ___ Very effective
2) ___ Somewhat effective
3) ___ Neutral
4) ___ Somewhat frustrated
5) ___ Very frustrated

(21) Safety Conscious:
1) ___ Very safety conscious
2) ___ Somewhat safety conscious
3) ___ Neutral
4) ___ Somewhat less safety conscious
5) ___ Much less safety conscious

(22) Feeling of Public Hostility:
1) ___ Is very hostile toward the police
2) ___ Is somewhat hostile
3) ___ Neutral
4) Is somewhat friendly
5) ___ Is very friendly toward the police

(23) Secure:
1) ___ Very secure
2) ___ Somewhat secure
3) ___ Neutral
4) ___ Somewhat insecure
5) ___ Very insecure

(24) Self-Confident:
1) ___ Very self-confident
2) ___ Somewhat self-confident
3) ___ Neutral
4) ___ Somewhat apprehensive
5) ___ Very apprehensive

35. **To what extent to you agree or disagree with the following statements?**
(25) "When your time is up, it's up, and there is nothing you can do to prevent it".
1) ___ Strongly agree
2) ___ Agree
3) ___ Neutral
4) ___ Disagree
5) ___ Strongly disagree

(26) "A good police officer doesn't need to wear a protective vest to adequately protect himself in any situation".
1) ___ Strongly agree
2) ___ Agree
3) ___ Neutral
4) ___ Disagree
5) ___ Strongly disagree

36. (27-28) **How many positive letters of commendation from citizens have you received in the last five years since January 1970?**
_____

37. (29-30) **How many negative letters from citizens have you received in the last five years since January 1970?** _____

38. (31) How do you think your fellow officers feel about your wearing a protective garment?
1)___ Highly complimentary
2)___ Complimentary
3)___ Indifferent
4)___ Critical
5)___ Highly critical

39. (32) What percent of the time do you anticipate wearing the protective garment during the summer (warm) months?
1)___ 100%
2)___ 75%
3)___ 50%
4)___ 25%
5)___ 0%

40. (33) What percent of the time do you anticipate wearing the protective garment during the winter (cold) months?
1)___ 100%
2)___ 75%
3)___ 50%
4)___ 25%
5)___ 0%

41. (34) What level of comfort do you anticipate?
1)___ Very comfortable
2)___ Comfortable
3)___ No change
4)___ Slightly uncomfortable
5)___ Very uncomfortable

OPTIONAL QUESTIONS

The following section contains a set of psychological test questions which were used in the University of Oklahoma study on assaults on police officers. This study showed a high degree of correlation between the answers to these questions and the number of times an officer was assaulted. They therefore could be considered a measure of the tendency of an officer to be assaulted. This would provide useful information in the evaluation of attitude changes before and after the test period.

It is recognized that you may have objections to answering these questions. If so, then please feel free to disregard them.

Following are twenty statements. Please read each question carefully and indicate the extent to which you agree or disagree by placing one of the appropriate numbers below to the left of the sentence.

1 Agree very much	4 Disagree a little
2 Agree on the whole	5 Disagree on the whole
3 Agree a little	6 Disagree very much

For example, if you feel on the whole that you disagree with the following statement "It is better to lie a little if the truth is going to hurt one you love", you should mark a 5 on the line opposite the statement.

(40) ____ In this complicated world of ours the only way we can know what's going on is to rely on leaders or experts who can be trusted.
(41) ____ My blood boils whenever a person stubbornly refuses to admit he's wrong.
(42) ____ There are two kinds of people in this world; those who are for the truth and those who are against the truth.
(43) ____ Most people just don't know what's good for them.
(44) ____ Of all the different philosophies which exist in this world, there is probably only one which is correct.
(45) ____ The highest form of government is a democracy and the highest form of democracy is a government run by those who are most intelligent.
(46) ____ The main thing in life is for a person to want to do something important.
(47) ____ I'd like it if I could find someone who would tell me how to solve my personal problems.
(48) ____ Most of the ideas which get printed nowadays aren't worth the paper they are printed on.
(49) ____ Man on his own is a helpless and miserable creature.
(50) ____ It is only when a person devotes himself to an ideal or cause that life becomes meaningful.
(51) ____ Most people just don't give a "damn" for others.
(52) ____ To compromise with our political opponents is dangerous because it usually leads to the betrayal of our own side.
(53) ____ It is often desirable to reserve judgment about what's going on until one has had a chance to hear the opinions of those one respects.
(54) ____ The present is all too often full of unhappiness. It is only the future that counts.
(55) ____ The United States and Russia have just about nothing in common.
(56) ____ In a discussion I often find it necessary to repeat myself several times to make sure I am being understood.
(57) ____ While I don't like to admit this even to myself, my secret ambition is to become a great man, like Einstein, or Beethoven, or Shakespeare.
(58) ____ Even though freedom of speech for all groups is a worthwhile goal, it is unfortunately necessary to restrict the freedom of certain political groups.
(59) ____ It is better to be a dead hero than to be a live coward.

BODY ARMOR FIELD EVALUATION
PRE-TEST INTERVIEW QUESTIONNAIRE
NON-WEARER CONTROL DATA

Officers:

We are about to initiate an experimental program sponsored by the Law Enforcement Assistance Administration and The Aerospace Corporation to evaluate lightweight body armor. Some members of your police department will be testing these garments and providing data on the comfort and performance during normal duty activities. It is expected that there will be some changes in attitude or performance of those groups of officers wearing the garments. To measure these changes and to identify them with the wearing of the garment, it is necessary to obtain comparative data from officers not wearing the garments. You are being requested to provide this basic data. If you elect to participate, you are requested to fill out the attached questionnaire at this time, and will be requested to fill out a similar questionnaire in approximately one year. The information you provide will be mathematically processed to obtain general statistical information.

Your cooperation in completing these questionnaires with the requested data is solicited and will be appreciated.

Thank you for your time and effort.

The National Institute of Law Enforcement and Criminal Justice and The Aerospace Corporation

INSTRUCTIONS: Please answer all questions. If a question is not applicable to you, please indicate by N.A.

1. Name _____
2. *(6-7) City _____
3. (8) Sex _____ M _____ F (1 / 2)
4. (9-10) Age _____
5. (11-13) Height _____ Ft. _____ In. (to nearest inch)
6. (14-16) Weight _____ lbs. (to nearest pound)

9. (26) Race: 1) ____ White
   2) ____ Black
   3) ____ Latin American
   4) ____ Indian
   5) ____ Other
10. (27) Marital Status:
   1) ____ Single
   2) ____ Married
11. (28-29) Number of dependent children: _____

8. Education: (Circle highest grade completed)

(23-24)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	PhD
(25)		Jr. Hi			Hi School			College							

_____ BA (1) _____ MA (2) _____ (3)

*Numbers in parentheses for Data Processing purposes only.

NWPT

13. (31) How many times have you participated in other experimental programs like this?
1) ____ None
2) ____ Once
3) ____ Twice
4) ____ Three or more times

14. (32) Would you classify your experience with experimental programs as:
1) ____ Good
2) ____ Fair
3) ____ Poor
4) ____ Not Applicable

15. (33) What is the predominant character of the area in which you work?
1) ____ Residential - Single Family
2) ____ Residential Apartments
3) ____ Commercial
4) ____ Industrial
5) ____ Mixed residential and business

16. (34) What is the predominant racial/ethnic composition of your assigned area?
1) ____ White
2) ____ Black
3) ____ Latin American
4) ____ Other (Specify)

17. (35) How long have you been a Police Officer?
1) ____ Less than 2 years
2) ____ 2 to 5 years
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18. (36) What is your present rank?
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19. (37) How often do you feel in danger of assault while on duty?
1) ____ Very often
2) ____ Often
3) ____ Occasionally
4) ____ Seldom
5) ____ Never

21. (42-43) In approximately how many of the assaults upon you did you touch the assailant before he touched you (e.g., to restrain, etc.)?
In ____ of them.

22. (44-45) In approximately how many of the assaults upon you had you issued an order to the assailant to do something in which he had refused?
In ____ of them.

23. (46-47) Approximately how many of these assaults occurred when you were alone?
In ____ of them.

24. (48-49) Approximately how many of these assaults occurred with a backup or fill unit present?
In ____ of them.

25. (50-51) In approximately how many of the assaults did the assailant attack without warning?
In ____ of them.

26. (52) How would you characterize the level of crime in your precinct?
1) ____ Very High
2) ____ High
3) ____ About Average
4) ____ Low
5) ____ Very Low

29. (55) If soft body armor were made available to you personally, how much would you be willing to spend annually to acquire a vest?
1) ____ Would not buy
2) ____ Less than $50
3) ____ $51 to $100
4) ____ $101 to $150
5) ____ $151 to $200
6) ____ Over $200
7) ____ Do not know

20. Approximately how many times have you been assaulted in the line of duty since January 1972? (violence or threat of violence)

	Never (1)	One time (2)	Two times (3)	Three times (4)	More than three times (5)	
(38)	____	____	____	____	____	Handguns
(39)	____	____	____	____	____	Shotguns and rifles
(40)	____	____	____	____	____	Other dangerous weapons
(41)	____	____	____	____	____	Hands, arms, fists, etc.

30. (56) **Do you think wearing soft body armor would make you more or less aggressive an officer?**
1) ___ Much less
2) ___ Less
3) ___ No different
4) ___ More
5) ___ Much more

31. (57) **From the following list indicate what you feel is an acceptable level of protection for a continuous wear garment on your normal street duty assignment?**

	Protection Level	Thickness (ins.)	Weight (lbs.)
1) ___	None	-	-
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6) ___	.41 mag	3/8	4.0
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32.a (**) **Current Duty Assignment:**
(5-6) ___ Auto Patrol 1)___ 1 man 2)___ 2 man
(7-8) ___ Motorcycle 1)___ Solo 2)___ 3-wheel
(9) ___ Traffic
(10) ___ Detective
(11) ___ Foot Patrol
(12) ___ Tactical Unit
(13) ___ K-9

32. (3-4) **Most frequent wear** _____ Uniform _____ Non-uniform

33. **Present Duty Hours:**
Indicate in military time to nearest hour:
(15-16) From: ____ (17-18) To: _____

(The following set of questions will be used to assess changes in attitude which may result over the period of the test program. The responses will be compared statistically before the test and after the test program. Your present answers should reflect your current attitude while on duty.)

34. **In your contact with the public while on duty do you feel:**

(19) Relaxed:
1)___ Very relaxed
2)___ Somewhat relaxed
3)___ Neutral
4)___ Somewhat tense
5)___ Very tense

(20) Effective in interacting with citizens:
1)___ Very effective
2)___ Somewhat effective
3)___ Neutral
4)___ Somewhat frustrated
5)___ Very frustrated

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1)___ Very safety conscious
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3)___ Neutral
4)___ Somewhat less safety conscious
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(22) Feeling of Public Hostility:
1)___ Is very hostile toward the police
2)___ Is somewhat hostile
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4)___ Is somewhat friendly
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(23) Secure:
1)___ Very secure
2)___ Somewhat secure
3)___ Neutral
4)___ Somewhat insecure
5)___ Very insecure

(24) Self-Confident:
1)___ Very self-confident
2)___ Somewhat self-confident
3)___ Neutral
4)___ Somewhat apprehensive
5)___ Very apprehensive

35. **To what extent do you agree or disagree with the following statements?**

(25) "When your time is up, it's up, and there is nothing you can do to prevent it."
1)___ Strongly agree
2)___ Agree
3)___ Neutral
4)___ Disagree
5)___ Strongly disagree

(26) "A good police officer doesn't need to wear a protective vest to adequately protect himself in any situation."
1)___ Strongly agree
2)___ Agree
3)___ Neutral
4)___ Disagree
5)___ Strongly disagree

36. (27-28) **How many positive letters of commendation from citizens have you received in the last five years since January 1970?**
_____

37. (29-30) **How many negative letters from citizens have you received in the last five years since January 1970?** _____

**Data Processing Card No. 2

OPTIONAL QUESTIONS

The following section contains a set of psychological test questions which were used in the University of Oklahoma study on assaults on police officers. This study showed a high degree of correlation between the answers to these questions and the number of times an officer was assaulted. They therefore could be considered a measure of the tendency of an officer to be assaulted. This would provide useful information in the evaluation of attitude changes before and after the test period.

It is recognized that you may have objections to answering these questions. If so, then please feel free to disregard them.

Following are twenty statements. Please read each question carefully and indicate the extent to which you agree or disagree by placing one of the appropriate numbers below to the left of the sentence.

1 Agree very much	4 Disagree a little
2 Agree on the whole	5 Disagree on the whole
3 Agree a little	6 Disagree very much

For example, if you feel on the whole that you disagree with the following statement "It is better to lie a little if the truth is going to hurt one you love," you should mark a 5 on the line opposite the statement.

(40) ____ In this complicated world of ours the only way we can know what's going on is to rely on leaders or experts who can be trusted.

(41) ____ My blood boils whenever a person stubbornly refuses to admit he's wrong.

(42) ____ There are two kinds of people in this world; those who are for the truth and those who are against the truth.

(43) ____ Most people just don't know what's good for them.

(44) ____ Of all the different philosophies which exist in this world, there is probably only one which is correct.

(45) ____ The highest form of government is a democracy and the highest form of democracy is a government run by those who are most intelligent.

(46) ____ The main thing in life is for a person to want to do something important.

(47) ____ I'd like it if I could find someone who would tell me how to solve my personal problems.

(48) ____ Most of the ideas which get printed nowadays aren't worth the paper they are printed on.

(49) ____ Man on his own is a helpless and miserable creature.

(50) ____ It is only when a person devotes himself to an ideal or cause that life becomes meaningful.

(51) ____ Most people just don't give a "damn" for others.

(52) ____ To compromise with our political opponents is dangerous because it usually leads to the betrayal of our own side.

(53) ____ It is often desirable to reserve judgment about what's going on until one has had a chance to hear the opinions of those one respects.

(54) ____ The present is all too often full of unhappiness. It is only the future that counts.

(55) ____ The United States and Russia have just about nothing in common.

(56) ____ In a discussion I often find it necessary to repeat myself several times to make sure I am being understood.

(57) ____ While I don't like to admit this even to myself, my secret ambition is to become a great man, like Einstein, or Beethoven, or Shakespeare.

(58) ____ Even though freedom of speech for all groups is a worthwhile goal, it is unfortunately necessary to restrict the freedom of certain political groups.

(59) ____ It is better to be a dead hero than to be a live coward.

BODY ARMOR FIELD EVALUATION
POST-TEST INTERVIEW QUESTIONNAIRE
GARMENT WEARER

Officers:

You have been participating in an experimental program sponsored by the Law Enforcement Assistance Administration and The Aerospace Corporation. The purpose of this program was to evaluate lightweight, inconspicuous, limited protection and continuous wear body armor. As part of this program you completed a pre-test interview questionnaire and monthly questionnaires designed to gather a variety of data on the garments, your acceptance or rejection of them, your attitude toward the garments and your attitude toward your job and the public while wearing the garment. The purpose of this questionnaire is to complete the data gathered during this program and to allow the evaluation of the protective garments in general and possible changes in the way law enforcement officers perform in their assignments while wearing the garments. Your cooperation thus far is sincerely appreciated. Your time and effort in completing the final questionnaire is solicited and will be similarly appreciated.

Thank you for your cooperation.

The National Institute of Law Enforcement and Criminal Justice and The Aerospace Corporation

INSTRUCTIONS: Please answer all questions. If a question is not applicable to you, please indicate by N.A.

1. Name (Optional) _____

   (1-5) Garment I.D. No. _____ (Mandatory)

2. *(6-7) City _____

10. (27) Marital Status:
   1) ____ Single
   2) ____ Married

14. (32) Would you classify your experience with this program as:
   1) ____ Excellent
   2) ____ Good
   3) ____ Fair
   4) ____ Poor

20. Approximately how many times have you been assaulted in the line of duty during the test period (violence or threat of violence).

	Never (1)	One time (2)	Two times (3)	Three times (4)	More than three times (5)	
(38)						Handguns
(39)						Shotguns and rifles
(40)						Other dangerous weapons
(41)						Hands, arms, fists, etc.

*Numbers in parentheses are for Data Processing purposes.

21. (42-43) In approximately how many of the assaults upon you did you touch the assailant before he touched you (e.g., to restrain, etc.)?
In _____ of them.

22. (44-45) In approximately how many of the assaults upon you had you issued an order to the assailant to do something in which he had refused?
In _____ of them.

23. (46-47) Approximately how many of these assaults occurred when you were alone?
In _____ of them.

24. (48-49) Approximately how many of these assaults occurred with a backup or fill unit present?
In _____ of them.

25. (50-51) In approximately how many of the assaults did the assailant attack without warning?
In _____ of them.

26. (52) How would you characterize the level of crime in your assignment?
1) ____ Very high
2) ____ High
3) ____ About Average
4) ____ Low
5) ____ Very Low

29. (55) If soft body armor were made available to you personally, how much would you be willing to spend annually to acquire a vest?
1) ____ Would not buy
2) ____ Less than $50
3) ____ $51 to $100
4) ____ $101 to $150
5) ____ $151 to $200
6) ____ Over $200
7) ____ Do not know

30. (56) Do you feel that while wearing soft body armor you were more or less aggressive as an officer?
1) ____ Much less
2) ____ Less
3) ____ No different
4) ____ More
5) ____ Much more

31. (57) From the following list indicate what you feel is an acceptable level of protection for a continuous wear garment on your normal street duty assignment.

	Protection Level	Thickness (ins.)	Weight (lbs.)
1) ____	None	-	-
2) ____	.38 special	1/8	1.5
3) ____	.45 auto	3/16	2.0
4) ____	.356 mag	1/4	3.0
5) ____	.9 mm auto	5/16	3.5
6) ____	.41 mag	3/8	4.0
7) ____	.44 mag	1/2	4.5

**Data Processing Card No. 2

32a. In what order would you recommend that your police department acquire the following equipment? (Rate 1 - 6)
(58) _____ communication helmet
(59) _____ improved airborne policing
(60) _____ lightweight body armor
(61) _____ active metal – weapon detection system
(62) _____ concealed recording system
(63) _____ routine wear ballistic helmet

32.(**) Current Duty Assignment:
(5-6) ___ Auto Patrol 1) ___ 1 man 2) ___ 2 man
(7-8) ___ Motorcycle 1) ___ Solo 2) ___ 3-wheel
(9) ___ Traffic
(10) ___ Detective
(11) ___ Foot Patrol
(12) ___ Tactical Unit
(13) ___ K-9
(14) ___ Other

33a. (16) What do you think the public feels about your wearing a vest?
1) ____ Good
2) ____ Indifferent
3) ____ Bad
4) ____ No opinion
5) ____ Not their concern

(The following set of questions will be used to assess changes in attitude which may result from wearing protective garments. The responses will be compared statistically before the test and after having worn the garments. Your present answers should reflect your current attitude while on duty).

34. In your contact with the public while on duty, when wearing body armor, do you feel:

(19) Relaxed:
1) ___ Very relaxed
2) ___ Somewhat relaxed
3) ___ Neutral
4) ___ Somewhat tense
5) ___ Very tense

(20) Effective in interacting with citizens:
1) ___ Very effective
2) ___ Somewhat effective
3) ___ Neutral
4) ___ Somewhat frustrated
5) ___ Very frustrated

(21) Safety Conscious:
1) ___ Very safety conscious
2) ___ Somewhat safety conscious
3) ___ Neutral
4) ___ Somewhat less safety conscious
5) ___ Much less safety conscious

(22) Feeling of Public Hostility:
1) ___ Is very hostile toward the police
2) ___ Is somewhat hostile
3) ___ Neutral
4) ___ Is somewhat friendly
5) ___ Is very friendly toward the police

(23) Secure:
1) ___ Very secure
2) ___ Somewhat secure
3) ___ Neutral
4) ___ Insecure
5) ___ Very insecure

(24) Self-Confident:
1) ___ Very self-confident
2) ___ Somewhat self-confident
3) ___ Neutral
4) ___ Somewhat apprehensive
5) ___ Very apprehensive

35. To what extent do you agree or disagree with the following statements?

(25) "When your time is up, it's up, and there is nothing you can do to prevent it".
1) _____ Strongly agree
2) _____ Agree
3) _____ Neutral
4) _____ Disagree
5) _____ Strongly disagree

(26) "A good police officer doesn't need to wear a protective vest to adequately protect himself in any situation".
1) _____ Strongly agree
2) _____ Agree
3) _____ Neutral
4) _____ Disagree
5) _____ Strongly disagree

36. (27-28) How many positive letters of commendation from citizens have you received while participating in the program?

_____

37. (29-30) How many negative letters from citizens have you received while participating in the program?

_____

38. (31) How do you think your fellow officers feel about your wearing a protective garment?
1) _____ Highly complimentary
2) _____ Complimentary
3) _____ Indifferent
4) _____ Critical
5) _____ Highly critical

39. (32) What percent of the time did you wear the protective garment during the summer (warm) months?
1) _____ 100%
2) _____ 75%
3) _____ 50%
4) _____ 25%
5) _____ 0%

40. (33) What percent of the time did you wear the protective garment during the winter (cold) months?
1) _____ 100%
2) _____ 75%
3) _____ 50%
4) _____ 25%
5) _____ 0%

41. (34) From your experience in wearing the garment would you say the general comfort level was:
1) _____ Very comfortable
2) _____ Comfortable
3) _____ No change
4) _____ Slightly uncomfortable
5) _____ Very uncomfortable

42. (35) From your observation of other officers wearing the LEAA garments, which is the most inconspicuous?
1) _____ Style 1 (full side protection)
2) _____ Style 2 (front and rear shaped panels)
3) _____ Both about the same

OPTIONAL QUESTIONS

The following section contains a set of psychological test questions which were used in the University of Oklahoma study on assaults on police officers. This study showed a high degree of correlation between the answers to these questions and the number of times an officer was assaulted. They therefore could be considered a measure of the tendency of an officer to be assaulted. This would provide useful information in the evaluation of attitude changes before and after the test period.

It is recognized that you may have objections to answering these questions. If so, then please feel free to disregard them.

Following are twenty statements. Please read each question carefully and indicate the extent to which you agree or disagree by placing one of the appropriate numbers below to the left of the sentence.

1 Agree very much	4 Disagree a little
2 Agree on the whole	5 Disagree on the whole
3 Agree a little	6 Disagree very much

For example, if you feel on the whole that you disagree with the following statement "It is better to lie a little if the truth is going to hurt one you love", you should mark a 5 on the line opposite the statement.

(40) ___ In this complicated world of ours the only way we can know what's going on is to rely on leaders or experts who can be trusted.

(41) ___ My blood boils whenever a person stubbornly refuses to admit he's wrong.

(42) ___ There are two kinds of people in this world; those who are for the truth and those who are against the truth.

(43) ___ Most people just don't know what's good for them.

(44) ___ Of all the different philosophies which exist in this world, there is probably only one which is correct.

(45) ___ The highest form of government is a democracy and the highest form of democracy is a government run by those who are most intelligent.

(46) ___ The main thing in life is for a person to want to do something important.

(47) ___ I'd like it if I could find someone who would tell me how to solve my personal problems.

(48) ___ Most of the ideas which get printed nowadays aren't worth the paper they are printed on.

(49) ___ Man on his own is a helpless and miserable creature.

(50) ___ It is only when a person devotes himself to an ideal or cause that life becomes meaningful.

(51) ___ Most people just don't give a "damn" for others.

(52) ___ To compromise with our political opponents is dangerous because it usually leads to the betrayal of our own side.

(53) ___ It is often desirable to reserve judgment about what's going on until one has had a chance to hear the opinions of those one respects.

(54) ___ The present is all too often full of unhappiness. It is only the future that counts.

(55) ___ The United States and Russia have just about nothing in common.

(56) ___ In a discussion I often find it necessary to repeat myself several times to make sure I am being understood.

(57) ___ While I don't like to admit this even to myself, my secret ambition is to become a great man, like Einstein, or Beethoven, or Shakespeare.

(58) ___ Even though freedom of speech for all groups is a worthwhile goal, it is unfortunately necessary to restrict the freedom of certain political groups.

(59) ___ It is better to be a dead hero than to be a live coward.

BODY ARMOR FIELD EVALUATION
POST-TEST INTERVIEW QUESTIONNAIRE
NON-WEARER CONTROL DATA

Officers:

We are nearing the conclusion of the experimental program sponsored by the Law Enforcement Assistant Administration and The Aerospace Corporation to evaluate lightweight body armor.

Approximately one year ago you completed a questionnaire requesting basic data on yourself and your assignment. This data has been entered into the data bank to assist in the garment evaluation. Since the program is now coming to a close, you are again requested to provide additional data by completing the attached form. This will be the final request you will receive. This data also will be entered into the data bank for evaluation purposes.

Your cooperation in completing these questionnaires with the requested data is solicited and will be appreciated.

Thank you for your time and effort.

The National Institute of Law Enforcement and Criminal Justice and The Aerospace Corporation

INSTRUCTIONS: Please answer all questions. If a question is not applicable to you, please indicate by N.A.

1. Name (Optional)_____

2. *(6-7) City_____

10. (27) Marital Status:
1) ____ Single
2) ____ Married

14. (32) Would you classify your experience with this program as:
1) ____ Excellent
2) ____ Good
3) ____ Fair
4) ____ Poor

21. (42-43) In approximately how many of the assaults upon you did you touch the assailant before he touched you (e.g., to restrain, etc.)?
In_____ of them.

22. (44-45) In approximately how many of the assaults upon you had you issued an order to the assailant to do something in which he had refused?
In_____ of them.

23. (46-47) Approximately how many of these assaults occurred when you were alone?
In_____ of them.

24. (48-49) Approximately how many of these assaults occurred with a backup or fill unit present?
In_____ of them.

20. Approximately how many times have you been assaulted in the line of duty during the test period (violence or threat of violence).

	Never	One time	Two times	Three times	More than three times
	(1)	(2)	(3)	(4)	(5)
(38) Handguns	____	____	____	____	____
(39) Shotguns and rifles	____	____	____	____	____
(40) Other dangerous weapons	____	____	____	____	____
(41) Hands, arms, fists, etc.	____	____	____	____	____

*Numbers in parentheses are for Data Processing purposes.

NWAT

25. (50-51) In approximately how many of the assaults did the assailant attack without warning?
In _____ of them

26. (52) How would you characterize the level of crime in your assignment?
1) ____ Very high
2) ____ High
3) ____ About Average
4) ____ Low
5) ____ Very Low

29. (55) If soft body armor were made available to you personally, how much would you be willing to spend annually to acquire a vest?
1) ____ Would not buy
2) ____ Less than $50
3) ____ $51 to $100
4) ____ $101 to $150
5) ____ $151 to $200
6) ____ Over $200
7) ____ Do not know

30. (56) Do you feel that while wearing soft body armor you would be more or less aggressive as an officer?
1) ____ Much less
2) ____ Less
3) ____ No different
4) ____ More
5) ____ Much more

31. (57) From the following list indicate what you feel is an acceptable level of protection for a continuous wear garment on your normal street duty assignment.

	Protection Level	Thickness (ins.)	Weight (lbs.)
1) ____	None	-	-
2) ____	.38 special	1/8	1.5
3) ____	.45 auto	3/16	2.0
4) ____	.356 mag	1/4	3.0
5) ____	.9 mm auto	5/16	3.5
6) ____	.41 mag	3/8	4.0
7) ____	.44 mag	1/2	4.5

32a. In what order would you recommend that your police department acquire the following equipment? (Rate 1 - 6)
(58) _____ communication helmet
(59) _____ improved airborne policing
(60) _____ lightweight body armor
(61) _____ active metal – weapon detection system
(62) _____ concealed recording system
(63) _____ routine wear ballistic helmet

32.(**) Current Duty Assignment:
(5-6) ____ Auto Patrol 1)____ 1 man 2)____ 2 man
(7-8) ____ Motorcycle 1)____ Solo 2)____ 3-wheel
(9) ____ Traffic
(10) ____ Detective
(11) ____ Foot Patrol
(12) ____ Tactical Unit
(13) ____ K-9
(14) ____ Other

33a. (16) What do you think the public would feel about your wearing a vest?
1) ____ Good
2) ____ Indifferent
3) ____ Bad
4) ____ No opinion
5) ____ Not their concern

(The following set of questions will be used to assess changes in attitude which may have resulted over the period of the test program. The responses will be compared statistically before the test and after the test program. Your present answers should reflect your current attitude while on duty.)

34. In your contact with the public while on duty, do you feel:

(19) Relaxed:
1)___ Very relaxed
2)___ Somewhat relaxed
3)___ Neutral
4)___ Somewhat tense

(20) Effective in interacting with citizens:
1)___ Very effective
2)___ Somewhat effective
3)___ Neutral
4)___ Somewhat frustrated
5)___ Very frustrated

(21) Safety Conscious:
1)___ Very safety conscious
2)___ Somewhat safety conscious
3)___ Neutral
4)___ Somewhat less safety conscious
5)___ Much less safety conscious

(22) Feeling of Public Hostility:
1)___ Is very hostile toward the police
2)___ Is somewhat hostile
3)___ Neutral
4)___ Is somewhat friendly
5)___ Is very friendly toward the police

**Data Processing Card No. 2.

(23) Secure:
1)___ Very secure
2)___ Somewhat secure
3)___ Neutral
4)___ Insecure
5)___ Very insecure

(24) Self-Confident:
1)___ Very self-confident
2)___ Somewhat self-confident
3)___ Neutral
4)___ Somewhat apprehensive
5)___ Very apprehensive

35. **To what extent do you agree or disagree with the following statements?**

(25) "When your time is up, it's up, and there is nothing you can do to prevent it"
1) ____ Strongly agree
2) ____ Agree
3) ____ Neutral
4) ____ Disagree
5) ____ Strongly disagree

(26) "A good police officer doesn't need to wear a protective vest to adequately protect himself in any situation"
1) ____ Strongly agree
2) ____ Agree
3) ____ Neutral
4) ____ Disagree
5) ____ Strongly disagree

36. (27-28) **How many positive letters of commendation from citizens have you received while participating in the program?**

_____

37. (29-30) **How many negative letters from citizens have you received while participating in the program?**

_____

38. (31) **How do you think your fellow officers would feel if you wore a protective garment?**
1) ____ Highly complimentary
2) ____ Complimentary
3) ____ Indifferent
4) ____ Critical
5) ____ Highly critical

OPTIONAL QUESTIONS

The following section contains a set of psychological test questions which were used in the University of Oklahoma study on assaults on police officers. This study showed a high degree of correlation between the answers to these questions and the number of times an officer was assaulted. They therefore could be considered a measure of the tendency of an officer to be assaulted. This would provide useful information in the evaluation of attitude changes before and after the test period.

It is recognized that you may have objections to answering these questions. If so, then please feel free to disregard them.

Following are twenty statements. Please read each question carefully and indicate the extent to which you agree or disagree by placing one of the appropriate numbers below to the left of the sentence.

1 Agree very much
2 Agree on the whole
3 Agree a little
4 Disagree a little
5 Disagree on the whole
6 Disagree very much

For example, if you feel on the whole that you disagree with the following statement "It is better to lie a little if the truth is going to hurt one you love", you should mark a 5 on the line opposite the statement.

(40)____ In this complicated world of ours the only way we can know what's going on is to rely on leaders or experts who can be trusted.

(41)____ My blood boils whenever a person stubbornly refuses to admit he's wrong.

(42)____ There are two kinds of people in this world; those who are for the truth and those who are against the truth.

(43)____Most people just don't know what's good for them.
(44)____Of all the different philosophies which exist in this world, there is probably only one which is correct.
(45)____The highest form of government is a democracy and the highest form of democracy is a government run by those who are most intelligent.
(46)____The main thing in life is for a person to want to do something important.
(47)____I'd like it if I could find someone who would tell me how to solve my personal problems.
(48)____Most of the ideas which get printed nowadays aren't worth the paper they are printed on.
(49)____Man on his own is a helpless and miserable creature.
(50)____It is only when a person devotes himself to an ideal or cause that life becomes meaningful.
(51)____Most people just don't give a "damn" for others.
(52)____To compromise with our political opponents is dangerous because it usually leads to the betrayal of our own side.
(53)____It is often desirable to reserve judgment about what's going on until one has had a chance to hear the opinions of those one respects.
(54)____The present is all too often full of unhappiness. It is only the future that counts.
(55)____The United States and Russia have just about nothing in common.
(56)____In a discussion I often find it necessary to repeat myself several times to make sure I am being understood.
(57)____While I don't like to admit this even to myself, my secret ambition is to become a great man, like Einstein, or Beethoven, or Shakespeare.
(58)____Even though freedom of speech for all groups is a worthwhile goal, it is unfortunately necessary to restrict the freedom of certain political groups.
(59)____It is better to be a dead hero than to be a live coward.

BODY ARMOR FIELD EVALUATION MONTHLY DATA QUESTIONNAIRE GARMENT WEARER

Officers:

This is the second type questionnaire in the series of three you are requested to complete as part of your participation in the experimental program sponsored by the Law Enforcement Assistance Administration and The Aerospace Corporation. You are asked to complete this questionnaire monthly while participating in the program. You will be asked to complete the third type questionnaire (post-test interview) at the end of your participation.

The data requested in this form will assist us in assessing changes in the program or garment wear and performance factors as the experiment progresses. These will be statistically analyzed with the pretest and post-test data to assess overall changes or trends throughout the test program.

Your cooperation in the timely completion of these questionnaires with the requested data is solicited and will be appreciated.

Thank you for your time and effort.

The National Institute of Law Enforcement and Criminal Justice and The Aerospace Corporation

INSTRUCTIONS: Please answer all questions. If a question is not applicable to you, please indicate by N.A.

1. Name _____

   *(2-6) Garment I.D. No. _____ (Mandatory)

2. (7-8) City _____

3. (9-14) Date _____ Month/Day/Year

4. (15) Duty Assignment since last report (Most of the time)
   1) ___ auto patrol (1 man)
   2) ___ auto patrol (2 man)
   3) ___ cycle/scooter
   4) ___ foot patrol
   5) ___ traffic
   6) ___ detective
   7) ___ tactical unit
   8) ___ K-9
   9) ___ Other

5. (16-17) Usual shift during month (Start time to nearest military hour)
   _____

6. (18) How would you characterize the level of crime in your duty area during the month compared to the city as a whole?
   1) ___ Very high
   2) ___ High
   3) ___ About average
   4) ___ Low
   5) ___ Very low

7. (19) What amount of the time did you wear the garment during the month?
   1) ___ All the time
   2) ___ All but a few hours
   3) ___ About half the time
   4) ___ A few hours
   5) ___ Did not wear at all

8. (20) What was the major reason for not wearing the garment?
   1) ___ Chafes
   2) ___ Binds
   3) ___ Rides up
   4) ___ Too hot
   5) ___ Too heavy
   6) ___ Too cumbersome
   7) ___ Inside duty
   8) ___ Did not want to
   9) ___ Not dangerous situation

*Numbers in parentheses are for Data Processing purposes.

WMD

9. (21) In which assignment did you wear the garment most frequently?
1)___ Routine patrol
2)___ Special Patrol
3)___ Investigations
4)___ Tactical assignment only
5)___ Other (Specify) _____

10. (22) Number of times garment was laundered during month?

11. (23) Number of times garment was dry cleaned during month?

12. (24) Number of times garment was water soaked during month (except normal laundering)?

13. (25) If the garment was soaked in any liquid other than water, please explain.

14. (26-35) The garment showed wear as follows:
(25)___ seams opening
(26)___ fasteners working loose
(27)___ buttons falling off
(28)___ ballistic material bunching up
(29)___ wear at crease location
(30)___ wear at material edges
(31)___ velcro does not hold well
(32)___ appearance deteriorating
(33)___ other _____
(34)___ none

	Agree strongly (1)	Agree (2)	Neither (3)	Disagree (4)	Disagree strongly (5)	
15. (36)						The garment is easy to put on and take off
16. (37)						The garment fits well
17. (38)						The garment allows free movement
18. (39)						The garment allows easy access to my weapon
19. (40)						The garment allows normal maneuverability
20. (41)						Wearing this garment increases my fatigue on duty
21. (42)						The garment hinders my movements while pursuing a suspect
22. (43)						The garment hinders my efforts to subdue an adversary
23. (44)						The garment interferes with my efforts during a rescue operation
24. (45)						The garment comfort remains the same throughout the shift
25. (46)						Frequent comments by the public indicate that the garment is easily detected
26. (47)						Fellow officers who do not wear protective garments frequently express interest in the garment
27. (48)						Wearing the garment increases my confidence in my ability to perform my assignment effectively
28. (49)						My contact with the public indicates they approve of protective garments for police officers

29. How many times were you assaulted during the month by the following weapons:

	Never (1)	One time (2)	Two times (3)	Three times (4)	Four times or more (5)
(50) Hand guns					
(51) Shotguns and rifles					
(52) Other dangerous weapons					
(53) Hands, arms, fists, etc.					

30. (54) Of the above assaults, how many resulted in injury requiring the following types of medical treatment?

1) ___ First aid
2) ___ Outpatient
3) ___ Less than one week hospitalization
4) ___ More than one week hospitalization

31. If you were to characterize any discomfort experienced in wearing the garment it would be:

	Very serious – cannot wear (1)	Serious – prevents wear for more than 2 hours (2)	Moderate – prevents wear for full shift (3)	Slight – noticeable (4)	Irritating only (5)
(55) Rides up					
(56) Chafes					
(57) Contains heat					
(58) Binds					
(59) Heavy					
(60) Cumbersome					

32. (62) The alarm-defense (fight-or-flight) reaction to a condition of extreme stress could result in a reaction which is known as hyperventilation. This reaction is characterized by an increase in breathing rate and depth which in various stages could result in sensations of prickling or tingling of the skin, muscle spasms, partial paralysis, and involuntary contractions of the extremities. This is not a frequently encountered reaction to stress conditions, but may be lessened or aggravated by tight fitting body armor. If you have experienced such a reaction during the month in a situation of high stress, either while wearing or not wearing armor, please check the box ☐ and explain briefly:

---

33. Precinct (Division, etc.) change during month

(63) From _____
(64) To _____

APPENDIX B

MODEL PROCUREMENT SPECIFICATION

THE AEROSPACE CORPORATION

Suite 4040, 955 L'Enfant Plaza, S.W., Washington, D.C. 20024, Telephone: (202) 484-5500

July 1977

Gentlemen:

The attached documentation is presented as suggested guidance to the procurement of lightweight limited protection garments based on the results of the Law Enforcement Assistance Administration supported Lightweight Body Armor Program.

The documentation contains recommendations of the number of plies of ballistic material required to defeat the threat specified. It also contains a recommended design and configuration to achieve maximum comfort and wearability. The recommendations have been purposely made less restrictive than a normal military specification for two primary reasons. First, the normal police department does not have the resources to mount a military type quality control and quality assurance inspection program; hence, the requirements are generally structured to limited visual and ballistic acceptance testing, with reliance on the contractor for certification of ballistic resistance quality. Second, the armor industry is making and has made advances during the course of the program. A less restrictive set of requirements allows for some flexibility and innovativeness on the part of the industry to improve upon the basic set of requirements based upon their experience.

The documentation addresses only the common handgun level of protection which is normally characterized by the .38 special handgun with standard ammunition. The reasons for this position are twofold. First, the greatest amount of trauma data both on animals and humans exists at these threat levels. As a result, the highest confidence exists that adequate protection can be provided against these threats. Secondly, the field test program indicates the maximum fatalities will be avoided with garments in the 8 to 10 ply region. With the garments tested, the advantage gained in providing heavier garments to defeat the higher energy handgun threats was lost through the tendency of the officers to not wear the heavier garments. This is particularly true of the continuous wear garments designed to defeat the .41 and .44 magnum handguns.

It is hoped that data contained in this document will be useful in developing your individual specifications for the procurement of lightweight continuous wear armor.

Very truly yours,

THE AEROSPACE CORPORATION

This project was supported by Contract Number J-LEAA-025-73 awarded by the National Institute of Law Enforcement and Criminal Justice, Law Enforcement Assistance Administration, U.S. Department of Justice, under the Omnibus Crime Control and Safe Streets Act of 1968, as amended. Points of view or opinions stated in this document are those of the authors and do not necessarily represent the official position or policies of the U.S. Department of Justice.

LIGHTWEIGHT BODY ARMOR PROGRAM

MODEL PROCUREMENT DOCUMENT

JULY 1977

REVISED SEPTEMBER 1977

BID REQUIREMENTS

Article: Protective Vest, undergarment type

Protection Level: 38 special 158 grain round nose lead up to 900 feet per second; .22 caliber 40 grain round nose lead up to 1080 feet per second.

Quantity: TBD

Construction: Per attached model procurement document

Size Distribution: The offeror shall be able to provide the following size distributions for male officers

Size	Chest (ins)	Height (ins)
Small regular	34 - 38	Less than 71
Medium regular	38 - 42	Less than 71
Large regular	42 - 46	Less than 71
Extra large regular	46 - 50	Less than 71
Small long	34 - 38	Greater than 71
Medium long	38 - 42	Greater than 71
Large long	42 - 46	Greater than 71
Extra large long	46 - 50	Greater than 71

The offeror has the option of providing garments in specific sizes (e.g., 38 short, long, regular, or 42 short, long, regular) providing the above schedule is maintained as a minimum.

Women's sizes shall be provided in small, medium, large, and extra large. Short, long and regular lengths shall be available. Sizes by bra cup sizes is desirable.

The size distribution required by this department is: TBD.

The offeror shall provide for special fitting of up to ten (10) percent of the male officers and up to twenty-five (25) percent of the female officers.

Prototype Garments: Each bid shall be accompanied by four (4) prototype garments. The prototypes shall consist of two each for both male and female officers. The prototype garments shall be fabricated in accordance with the attached documentation and be identical to the proposed deliverable items. The prototype garments will be evaluated as part of the officer's bid package. Prototypes supplied by unsuccessful bidder will be returned. The successful offeror prototypes will be retained as first articles to be used as quality assurance standards and as models for acceptance inspection.

Bid Response: All bids shall be delivered to the _____ no later than_____PM on_____ Each bid must be accompanied by the four prototype garments to receive consideration.

Delivery Schedule: All garments shall be delivered within_____weeks of award of contract. An additional fifteen (15) days will be allowed for special order garments.

Facilities Inspection: The purchaser reserves the right to visit offeror's facilities as part of the bid evaluation effort. The purpose of such a visit will be to evaluate the adequacy of quality control system and methods.

Packaging: Each garment shall be folded in accordance to the offeror's standard practices to assure garment integrity during storage. Each garment shall be individually packaged such that moisture and pollutants are excluded during shipment and storage.

Containers: Each package container shall be such that garment wear and abrasion are prevented during normal handling and shipping. Each container shall be marked or labelled on the end and side with a description indicating the sizes and

quality of each garment contained therein. The labeling shall also specify male or female officers' garments.

Warranty: The offeror shall warrant his product against defects in material and workmanship for a period of two (2) years. This warranty shall include repair or replacement at no cost to the purchaser.

Delivery: Delivery shall be freight prepaid to the purchaser.

MODEL PROCUREMENT DOCUMENT

1.0 Scope and Classification

1.1 Scope - This document establishes the design, fabrication, quality assurance and delivery requirements for ballistic-resistant garments for the (enter name of the particular Law Enforcement agency).

1.2 Classification - The protective garments delivered under this document shall be designated protective undervests and shall provide front, side, and rear upper torso coverage. They shall be lightweight, flexible and configured to be worn continuously under the uniform shirt while on duty.

2.0 Requirements

2.1 Configuration - The overall design shall be a modified undershirt type. The garment shall be of a slipover construction and shall be adjustable in the chest and waist area. The garment shall be in two parts; an outer shell or carrier and a snug-fitting inner unit comprising the ballistic penetration-resistant component. The ballistic component must be removable to enable laundering of the outer shell. The garment shall be of wrap-around configuration in the waist area to provide side protection under the arms. Tails shall be provided front and rear on the carrier to minimize riding up of the garment. The garment design concept shall be the same for both male and female officers. Different design details shall be provided for male and female officers to assure optimum fit and comfort. Figure 1 shows the general configuration of the garment.

2.2 Level of Protection - The garments provided under this document shall provide ballistic impact protection against both penetration and serious internal injury to an officer wearing the garment when impacted with the following projectiles on the protected area:

a) .22 caliber 40 grain round nose lead projectile at up to 1080 feet per second.

b) .38 special caliber (.357 dia.) 158 grain round nose lead projectile at up to 900 feet per second.

This requirement also covers both penetration and serious injury protection against all other handgun projectiles between .22 and .38 special caliber with velocities less than 850 feet per second (i.e., .32 caliber, .25 automatic, etc.).

3.0 Construction

3.1 Outer Shell - The outer shell shall be constructed front and rear in the form of inner and outer covers into which a pre-packaged ballistic component may be inserted. The cover shall open on the bottom and be resealable with a suitable nonmetallic closure. All joining seams shall be underlayed to prevent fraying. The shoulder straps shall be at least two inches wide at their minimum dimensions. Seams on the top of the shoulder area shall be so constructed as to minimize chafing or other discomfort. The neck cut out shall be sufficiently scooped so that the vest is not visible at the open throat of the shirt on a standing officer when the collar is unbuttoned and without a tie. A vest with full wrap-around protection shall be sufficiently relieved in the arm opening area so as not to restrict the officer's movements when driving a car or in the combat-facing, pistol firing stance with a two-hand grip. Relief under the arm shall be such that the garment does not ride up and chafe the wearer under the arm. Where the front and rear panels meet at the sides, they shall butt or meet with a small gap for optimum fit. Certain situations may exist where an overlap of the front and rear panels is necessary. The configuration of the adjustment straps shall be such that the front panel will overlap the rear when properly adjusted.

3.1.1 Material - The outer shell material shall be a blend of fifty (50) percent cotton and fifty (50) percent polyester. The material color shall be white (or as specified by the procuring agency). The minimum fabric weight shall be five (5) ounces per square yard. The garment tail front and rear may be 100 percent cotton or a polyester-cotton blend of a weight of not less than three and one-half (3.5) ounces per yard. The preferred configuration is to have the tail and shell material the same 50 percent blend with a minimum weight of five (5) ounces per square yard.

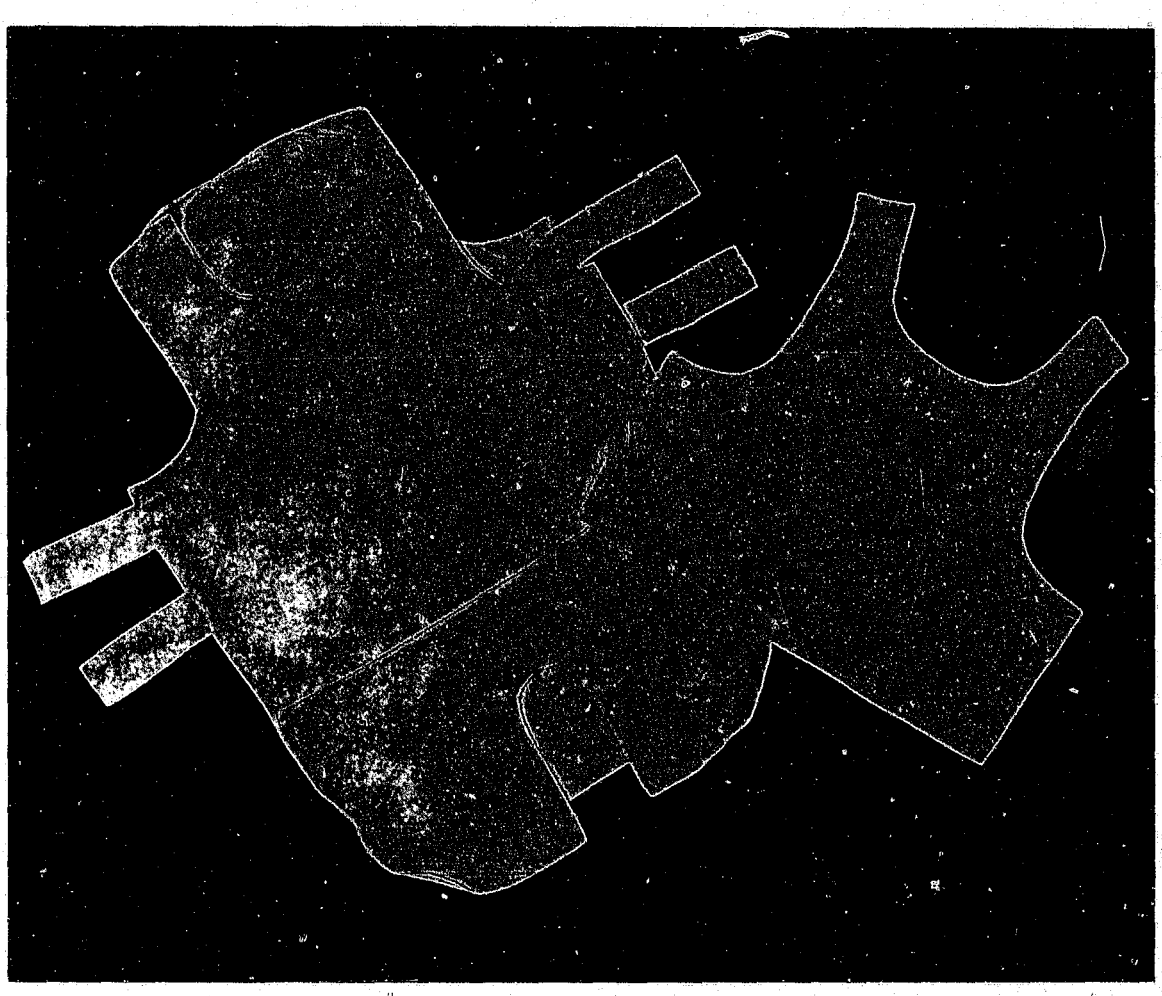

Figure 1. Garment General Configuration

3.1.2 Seams and Stitching - All seams and stitching shall be consistent with good garment manufacturing practices.

3.1.2.1 Structural Seams and Stitches - All line-stitching shall have a minimum of eight (8) stitches per inch and a maximum of twelve (12) stitches per inch in high stress areas (stitch type 301 per Federal Standard No. 751). All stitching should be backstitched or over-stitched on half-inch minimum except where ends are turned under a hem or held down by other stitching. Thread tension shall be maintained so that there will be no loose stitching or excessively tight stitching which would result in puckering of the material. Stitching repairs shall be consistent with good commercial practices.

3.1.2.2 Over-Edge Stitching - All over-edge stitching shall have a minimum of five (5) and a maximum of nine (9) stitches per inch (stitch type 500 series per Federal Standard No. 751). Thread tension shall be maintained such that there are no loose stitches.

3.1.2.3 Thread - Thread shall be compatible with the material being sewn and a size appropriate to the expected usage. It shall not shrink during washing so as to cause puckering of the material.

3.1.2.4 Thread Lubrication - There shall be no lubrication of the thread prior to or during the sewing operations.

3.1.3 Adjustment Straps - Two sets (four straps per garment) of adjustment straps shall be provided. These straps shall be not less than two (2) inches wide. Velcro* hook and pile fasteners shall be provided on each strap allowing a minimum of plus or minus two (2) inches adjustment in each strap. The female pads shall be sewn on the front of the carrier while the male pads shall be sewn to the straps. The straps shall be attached to the rear panel of the carrier to allow a minimum of one inch

*Velcro is the registered trademark of the Velcro Corporation.

overlap of the front panel. Each strap shall contain at least three (3) inches of good quality elastic at least two (2) inches wide to allow give in the garment to compensate for body movement.

On the women's garments, the adjustment straps may be configured to fasten on the rear of the garment to improve appearance.

3.1.4 Ballistic Insert Closure - The bottom closure on the front and rear of the carrier shall consist of Velcro hook and pile a minimum of three-eights (3/8) inch wide or equivalent. Other closure options are acceptable provided they contain no metal or metallic parts and are approved by the procuring agency.

3.1.5 Defects - The following defects shall be unacceptable:

Type	Description
Material Defects	Any hole, cut, tear, drop stitch, thin area, mends
Color	Not the proper color
Components	Any component missing or other than specified
Seams and Stitching	Needle chews
	Any part of the garment badly pleated caught or twisted in any unrelated row of stitching
	Wrong seam type
	Wrong stitch type
Open Seam	Any open seam, except hems

The purchaser shall be the sole judge for rejecting a garment due to defects. The offeror shall determine whether the rejected garment(s) shall be repaired or replaced. The acceptance of a repaired garment shall be at the purchaser's discretion.

3.2 Ballistic Insert - The ballistic insert shall consist of front and rear units. The ballistic insert shall be installed through the opening provided in the bottom of the outer shell. The insert shall fit snugly into the outer shell with minimum or no relative movement between the insert and the shell. The ballistic material shall extend upward into the shoulder strap area as far as possible consistent with installation and removal requirements. Some tapering (stepping of plies) is allowable in the upper shoulder strap area to improve appearance and enhance concealment. The ballistic inserts may be constructed in either of two methods: A separate polycotton cover may be fabricated to contain the eight plies of ballistic material or the outer two plies may be assembled in such a way as to form the cover for the remaining six plies.

3.2.1 Ballistic Insert Cover Construction - The two methods of constructing the ballistic insert cover are described in the following sections.

3.2.1.1 Polycotton Cover - The required eight plies of ballistic material may be enclosed in a separate polycotton cover. The cover material shall be a 50 percent cotton/50 percent polyester blend material with a minimum weight of five (5) ounces per square yard. Each cover shall consist of two pieces of material cut to the shape of the ballistic material but approximately one-half inch larger around the periphery. The two cover pieces shall be sewn over the top and down each side with type 301 stitching. The sewn panels shall then be turned inside out to form a shaped cover for the ballistic material. When the ballistic material has been placed in the cover, the remaining bottom edges shall be turned and the bottom stitched closed. Vinyl or other waterproof or water resistant materials shall not be used for the cover material.

3.2.1.2 Alternate Cover Construction - The allowable alternate cover construction shall comprise the outer two plies of ballistic material. The outer two plies shall be cut sufficiently larger than the

remaining six plies of ballistic material to allow the sewing of 3/4 inch or wider bias binding material around the entire periphery to the outer two plies only. All eight plies shall not be edge sewn together and only the six inner plies shall be bartacked together.

If this method is used, the manufacturer shall assure the stitching is adequate to engage sufficient yarns in the ballistic fabric to prevent the pullout of the fabric from the edge binding.

3.2.2 Ballistic Material

3.2.2.1 Yarn - The yarn shall be Kevlar* -29 nominal 1000-denier aramid fiber. The yarn has the following nominal characteristics†:

Density	1.44 gm/cc
No. of Filaments	666
Tensile Strength	400,000 psi
Yarn Breaking Strength	46 pounds

3.2.2.2 Construction - The fabric shall be constructed in a plain weave with a 31 pics and ends per inch in both the filling and warp directions. The average count of the warp ends and filling pics shall be 31-1/2+1 per inch, for a randomly selected 10 sample count in each direction. The yarn shall have normal manufacturer's twist.

3.2.2.3 Color - The finished fabric shall be natural as produced from the yarn provided by duPont.

3.2.2.4 Finish - The finished cloth shall be thoroughly scoured. The supplier shall certify that no bleaching or loading material has been applied in processing the cloth.

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*Kevlar and Zepel are registered trademarks of the E. I. duPont Corporation.

†These values are nominal values. The duPont Corporation specification should be consulted for actual values guaranteed by duPont.

3.2.2.5 Fabric Treatment - The fabric shall be treated with fluorochemical water repellent material such as E. I. duPont Zepel-D or equivalent with a formulation of four (4) percent of the product on the fabric.

3.2.2.6 Defects - None of the following defects shall be allowed in the woven Kevlar fabric contained in the protective garments:

Type	
Baggy; ridgy or wavy cloth	Clearly noticeable
Crease	Hard, embedded and folded over
Cut or tear	Clearly noticeable in any direction, any size
Hole	Clearly noticeable, any size

3.2.3 Number of Plies - The insert shall contain not less than eight plies or layers of Kevlar fabric as described in Paragraph 3.2.2.

3.2.4 Seams and Stitching - All seams and stitching on the insert shall comply with the requirements of Paragraph 3.1.2. The structural seams in the ballistic material shall be such that a minimum of one-half (1/2) inch material overlap exists on each side of the seam stitch for each ply.

3.2.5 Ballistic Material Layup - To maximize the flexibility of the final garment, the individual plies of ballistic material should be free to slide over each other. Therefore, the material layup shall have no stitching through the plies other than that required for assembly. The only stitching which shall be allowed is a bar tack in each shoulder strap, the low point of the neck scoop, and at each corner of the wrap-around area to facilitate assembly and drape of material. If desired, for appearance considerations, the upper ends of the shoulder strap inserts may be tapered (ply-stepped to a minimum of three (3) plies). The taper shall not exceed two (2) inches.

3.2.6 Assembly - The cover and ballistic material shall be assembled so that the ballistic material cannot be removed without opening a seam of the cover. The cover and ballistic material shall not be sewn together.

3.3 Labels and Other Markings

3.3.1 Outer Shell - The outer shell shall contain a label with the following information:

Manufacturer's Name
Manufacturer's Address
Garment Size
Level of Protection
Warning to remove ballistic inserts prior to washing
Washing and drying instructions

3.3.2 Ballistic Insert - The ballistic insert shall have the following information contained on a label affixed to the cover or otherwise indelibly imprinted on the insert:

Manufacturer's Name
Manufacturer's Address
Identification - front or rear
Level of Protection
Size
Month and year of manufacture
Fabric lot number
Cleaning instructions
Special identification of side toward body if required

3.4 Workmanship - All workmanship shall be of top quality and consistent with good garment manufacturing practices.

4.0 Quality Assurance

4.1 Certifications

4.1.1 Fabric Certification - For each lot of material the offeror shall supply the following certifications. The certifications must be supplied by the offeror and/or the fabric weaver based on their records.

4.1.1.1 Yarn Material - The Yarn shall be certified as duPont Kevlar-29.

4.1.1.2 Yarn Denier - The yarn used to weave the delivered lot(s) of material shall be certified as nominal 1,000 denier.

4.1.1.3 Yarn Merge - The weaver shall provide certification the fabric is woven from a single merge of yarn supplied by duPont, and shall identify that merge.

4.1.1.4 Yarn Tensile Strength - The yarn used in weaving the lot(s) of material shall be certified as having been delivered and tested to the quality assurance provisions for ballistic Kevlar as specified by duPont. The tensile breaking strength shall be made on samples not less than ten (10) inches in length. The samples shall be twisted with three (3) plus or minus one quarter (1/4) twists per inch prior to installation in the test fixture.

4.1.1.5 Weave - The weave shall be a plain weave.

4.1.1.6 Thread Count - For each 500 yards or part thereof from a single lot of material the supplier shall certify the thread count requirements of Paragraph 3.2.2.2 have been met.

4.1.1.7 Fabric Lot - The supplier shall identify the weaving manufacturer and the lot number(s) of the material. The supplier shall certify that the garments were manufactured from the lot(s) of material identified on the ballistic inserts, and the remaining certifications have been supplied.

4.1.2 Fabric Ballistic Nonpenetration Certification - The supplier shall provide the following certifications concerning the ballistic penetration resistance.

4.1.2.1 Test Fabric Identification - The supplier shall certify that the ballistic test samples were taken from the lot(s) of material from which the garments are manufactured.

4.1.2.2 Test Conditions - The supplier shall certify that the following conditions were met for ballistic testing. An alternate test method may be used if the alternate method complies with an approved or generally accepted test standard (such as NILE/CJ-STD-0101.01 when released).

4.1.2.2.1 Muzzle to Target Distance - Three (3) to four (4) meters).

4.1.2.2.2 Test Projectiles - Round-nose lead bullets: .22 caliber at nominal forty (40) grains and 38 special (.357 caliber) at nominal one hundred fifty-eight (158) grains. All test projectiles shall be targeted to impact within ±5 degrees of perpendicular to the armor surface.

All projectiles shall be of American commercial manufacture.

4.1.2.2.3 Test Velocities - The test velocities for the .22 caliber projectile shall be between 1,000 and 1,080 feet per second. The test velocity for the .38 special caliber projectile shall be between 800 and 900 feet per second.

4.1.2.2.4 Ballistic Certification Targets - The test targets shall be identical in construction to the delivered garments. The targets shall be a minimum of twelve (12) by twelve (12) inches. The targets shall be constructed from randomly selected areas of the total lot(s) of material which will be used to fabricate the garments. If so desired by the vendor, randomly selected finished garments from the lot(s) to be delivered may be used as test targets.

4.1.2.2.5 Fair Hits - A fair hit shall be at least two (2) inches from the edge of the target sample. It shall be greater than two (2) inches from any previous impact point in a radial direction.

4.1.2.3 Number of Targets - The contractor will prepare using fabric randomly selected from that used in the delivered garments, a number of target samples in accordance with Single Sampling Plan for Normal Inspection, General Inspection Level I, with Acceptance Quality Level (AQL) of 0.25 specified in MIL-STD-105 as shown in Table I. Twenty (20) percent of the target samples shall have duplicates of any seams in the ballistic fabric which will be used in fabricating the garments.

TABLE I

SAMPLING SCHEDULE

Lot Size	Number of Inspection Units	Number of Non-Conforming Units to Reject
1-90	5	1
91-150	8	1
151-280	13	1
280-500	20	1
501-1200	32	1
1201-3200	50	1
3201-10000	80	1

4.1.2.4 Backing Material - The supplier shall certify that all ballistic non-penetration tests were conducted using Roma Plastilina Number 1 clay as a backing material. The clay shall be at least 12×12×6 inches. The clay shall be worked prior to testing to assure the absence of voids. The clay shall be reworked after each shot to fill the cavity and any other voids and to present a smooth surface. The clay block shall be changed after every 10 shots. The clay shall be maintained at 70°F ± 2°F during testing.

4.1.2.5 Target Smoothing - The target material shall be smoothed against the surface of the clay prior to each shot.

4.1.2.6 Definitions

4.1.2.6.1 No Penetration - The projectile is stopped at the first ply of Kevlar. No yarns are broken.

4.1.2.6.2 Partial Penetration - The projectile penetrates one or more plies of the material but not the last ply.

4.1.2.6.3 Complete Penetration - The projectile passes completely through all plies in the target or is stopped in the eighth or last ply but breaks two or more yarns in that ply.

4.1.2.7 Performance Certification - The contractor shall certify that the following ballistic performance requirements were met for each set of test panels. At least two (2) .22 caliber and two (2) .38 special caliber projectiles must impact the test seam or actual seam to demonstrate the women's garments seam integrity.

4.1.2.7.1 Ballistic Penetration - There shall be no complete penetrations of the .22 caliber projectile in five (5) fair hits on each tested panel with measured velocities between 1000 and 1080 feet per second.

4.1.2.7.2 Measured Deformation - The average clay cavity depth behind the point of impact of five (5) fair hits of .38 special projectiles striking at velocities between 800 and 900 feet per second shall not exceed 4.4 cm. No single cavity shall exceed 4.8 cm in depth.

4.2 Acceptance - Acceptance of the end items shall be based on receipt and verification of the certifications required in Paragraph 4.1 of this specification. In addition, receiving inspection, quality assurance inspection and limited ballistic testing will be conducted by the purchaser as part of the acceptance conditions.

4.2.1 Visual Examination - The garments shall be visually inspected for defects listed in Paragraph 3.1.5 of this specification.

4.2.2 Ballistic Acceptance Tests - Two garments in each lot of 500 or less may be used for destructive tests. The garments will be tested in accordance with Paragraphs 4.1.2.2, 4.1.2.4, 4.1.2.5, 4.1.2.6, and 4.1.2.7 of this specification. The supplier will furnish the two extra garments per lot of 500 or less for testing and the selection will be random at time of delivery. Failure to pass the ballistic tests will be cause for rejection of the complete lot of garments.

4.2.3 Rejected Garments - The purchaser shall be the sole judge of defects in material and workmanship. The criteria for acceptance or rejection shall be in compliance with this specification and reproducibility of the delivered garments compared to the first article(s) submitted with the proposal. Repair or replacement shall be at discretion of the supplier, however, acceptance of repaired garments shall be solely up to the discretion of the purchaser.

APPENDIX C

DISSEMINATION

APPENDIX C. DISSEMINATION

Briefings on the results of the Body Armor Program were presented to the nation's major law enforcement agencies during July and August of 1977. Invitations were sent to all police departments with more than 1000 sworn officers in an attempt to maximize coverage. The letters of invitation urged that smaller, neighboring jurisdictions be invited to attend. In addition, briefings were presented to each of the test cities that participated in the field test and evaluation. State and county agencies, as well as city departments, were included. Out of 57 agencies invited, 45 accepted and 12 declined. The most common reasons given for not attending were a lack of money for purchase, or the fact that the department had an ongoing armor program.

The briefings were enthusiastically received by all participants. In particular, the interest and inquiries from participants representing the smaller law enforcement agencies are indicative of the need for the widest possible dissemination of the Body Armor Final Report. As this report is being written, The Aerospace Corporation has been advised that a number of jurisdictions have decided to use the recommended armor procurement guidelines contained in the LEAA Body Armor Briefing (of Appendix B) as the basis for their department's purchase of protective garments.

The host agencies, participating agencies, and number of attendees to the series of briefings are shown in Table C-1. 183 jurisdictions are represented.

Table C-1. Body Armor Briefings Attendance List

Host	Participating Agencies	No. of Attendees
Richmond City Police		7
Prince George's County Police		2
	Arlington County Police Dept.	2
	Falls Church Police Dept.	2
	Fairfax City Police Dept.	2
Memphis City Police		18
Baltimore City Police		9
	Baltimore County Police	3
	Maryland State Police	4
	Anne Arundel County Police Dept.	2
	Millington Police Dept.	1
	Bartlett Police Dept.	1
	Shelby County Sheriff's Dept.	2
	Tacoma Park	1
Council of Governments	Triangle J Council of Govts.	1
	Cumberland County Sheriff's Dept.	3
	Pinetop Police Dept.	2
	North Carolina State Bureau of Investigation	1
	Cary Police Dept.	1
	Henderson Police Dept.	3
	High Point Police Dept.	3
	E. C. U. Police Dept.	2
	Durham County Sheriff's Dept.	1
	Iredell County Sheriff's Dept.	2
	Wendell Police Dept.	1
	Criminal Justice Service Comm.	2
	Wake Tech. Institute	1
	East Carolina Univ. Police	1
	N. C. Dept. of Correction	2
	Carrboro Police Dept.	3
	Apex Police Dept.	2
	Charlotte Police Dept.	2
	Orange County Sheriff's Dept.	1
	Locust Police Dept.	2

Table C-1. Body Armor Briefings Attendance List (Continued)

Host	Participating Agencies	No. of Attendees
Council of Governments (continued)	S.B.I.	1
	Triangle Comm. on Criminal Justice	1
	Durham Police Dept.	1
	Wake County Sheriff's Dept.	1
	Statesville Police Dept.	1
	Durham Public Safety	1
	Duke Power Co.	1
	Elon College Security	1
	Madison Police Dept.	1
	Dorothea Dix Hospital	1
	Fremont Police Dept.	1
Washington City Police		23
	D.C. Fire Dept.	1
New York State Police		12
	Rotterdam Police Dept.	1
	Schenectady Police Dept.	1
	Waterford Police Dept.	2
New York City Police		23
	Yonkers Police Dept.	2
	Mt. Vernon Police Dept.	1
	Town of Greensburgh Police Dept.	1
	Port Authority Police	1
	S.O.D.	1
	Amtrak Police Dept.	1
	Office of the New York City Deputy Mayor for Criminal Justice	1
	U.S. Dept. of State	1
	U.S. Customs Region II	1
	Naval Investigative Service	1
	U.S. Treasury, Alcohol, Tobacco, and Firearms	2
	F.B.I.	1
	U.S. Dept. of Justice - DEA	2
	Housing Police Dept.	1
	NYC Housing Authority Police Dept.	2
	NYC Transit Police Dept.	2

Table C-1. Body Armor Briefings Attendance List (Continued)

Host	Participating Agencies	No. of Attendees
Boston City Police		4
	Cambridge Police Dept.	2
	Massachusetts State Police	1
	Metropolitan District Police	2
	Capital Police	1
	Newton	1
Nassau County Police		16
	Garden City Police	1
	Lynbrook Police	1
	Hempstead Police Dept.	2
	Sands Point Police Dept.	2
	Malverne Police Dept.	1
	Floral Park Police	2
	Suffolk County Police Dept.	2
Detroit City Police		8
Columbus City Police		8
	Whitehall Ohio Police Dept.	2
	Circleville Police Dept.	1
	Marysville Ohio Div. of Police	2
Cleveland City Police		9
	Cayahoga County Sheriff Dept.	1
	Lyndhurst	2
Indianapolis City Police		13
	Marion County Sheriff	2
	U.S. Secret Service	1
	Indiana State Police	3
Newark City Police		4
Philadelphia City Police		5
St. Paul City Police		1
St. Louis City Police		1
	Jennings Police	1
	Franklin County Sheriff Dept.	1
	University City Police	1
	St. Louis County Police Dept.	1

Table C-1. Body Armor Briefings Attendance List (Continued)

Host	Participating Agencies	No. of Attendees
Illinois State Police		9
	F.B.I.	1
	Peoria Illinois Police Dept.	1
	Kankakee County Sheriff's Police	1
	Illinois Dept. of Law Enforcement	3
	Jacksonville Police Dept.	1
	Morgan County Sheriff's Dept.	1
	Sangamon County Sheriff's Office	1
Houston City Police		6
	Riveroats Police Dept.	2
Michigan State Police		7
	Lansing Police Dept.	2
	Eaton County Sheriff	1
	Lansing Comm. College Dept. of Public Safety	1
Atlanta City Police		4
San Antonio City Police		4
Birmingham City Police		38
Milwaukee City Police		20
Florida Highway Patrol		18
New Orleans City Police		6
Miami City Police		12
Tampa City Police		9
Denver City Police		2
	Lakewood Police Dept.	1
	Colorado Springs Police Dept.	3
	Denver Research Institute/ University of Denver	1
	Colorado State Patrol	2
	Greenwood Village	1

Table C-1. Body Armor Briefings Attendance List (Continued)

Host	Participating Agencies	No. of Attendees
Denver City Police (continued)	Englewood Police	1
	Wheat Ridge Police Dept.	2
	Lakewood Public Safety	1
Seattle City Police		13
Portland City Police		12
	Gresham Police Dept.	1
	Clackamas County Sheriff's Dept.	1
	Washington County Sheriff's Office	1
	Lake Oswego Police Dept.	2
	Oregon State Police	1
	Columbia County Sheriff's Office	1
	Tigard Police Dept.	2
	Clark County Police Dept.	1
Albuquerque City Police		10
Tucson City Police		13
Kansas City Police		2
	Overland Park, Kansas Police Dept.	1
San Diego City Police		2
	San Diego County Sheriff Dept.	1
	S. D. S. O.	1
	National City Police	1
	Imperial Beach Police	1
	Armour of America	2
The Aerospace Corporation	Los Angeles City Police	1
	El Segundo Police Dept.	4
	Hermosa Beach	1
	Signal Hill Police Dept.	3
	Bell Gardens Police Dept.	2
	Long Beach Police Dept.	2
	Montebello Police Dept.	2
	La Mesa Police Dept.	1
	Imperial Beach Police	1

Table C-1. Body Armor Briefings Attendance List (Continued)

Host	Participating Agencies	No. of Attendees
California Highway Patrol		7
	California Dept. of Justice	1
San Francisco City Police		2
	Pleasant Hill Police Dept.	1
	Mt. View Police Dept.	1
	Oakland Police Dept.	1
	Foster City Police Dept.	1
	Special Enforcement Detail Sacramento Sheriff	1
	Newark Police Dept.	2
	San Rafael Police Dept.	1
	Daly City Police Dept.	1
	Merced S/O	2
	Walnut Creek Police Dept.	1
	Concord Police Dept.	1
	Training Bureau Sacramento Sheriff	1
Honolulu City Police		22

APPENDIX D

NATICK TEST PLAN

Body Armor Field Test Program

Garment Comfort Comparison Tests

1.0 INTRODUCTION

1.1 Purpose

The purpose of this test series is to obtain laboratory data on the relative thermal indicies and wear performance of three types of ballistic protection undergarments.

1.2 Scope

This series of tests will be performed utilizing the unique instrumentation systems available only at the U. S. Army Natick Research and Development Command and Research Institute of Environmental Medicine (ARIEM) which are known as the "copper man", and the "anatomical load analyzer". Three garments will be tested and are identified as follows:

Identification	Description
A-1	Style I LEAA garment used in field test with the ballistic material integrated into the garment
A-2, A-3	Two versions of a new garment design incorporating a carrier

The test series will consist of determining the relative insulation index (clo) and evaporative cooling coefficient $\frac{i_m}{clo}$ using the copper man, and load distribution comparisons using load profile analysis among the three garments under preselected conditions. The test series will include measurement of the water absorption of the three garments with the copper man wetted to simulate perspiration.

1.3 Background

Over the past four years, the Law Enforcement Assistance Administration (LEAA) has funded a program to develop and field test lightweight

protective garments. During the past year, approximately five thousand garments have been operationally tested by participating officers in fifteen (15) police departments throughout the country. During the test, 1,850 Style I garments were worn (Figure I). As a result of the testing, a number of changes are being recommended. The most significant change is from a design in which ballistic material is an integral part of the garment to one in which the ballistic material is contained in a separate insert which may be installed in and removed from a carrier (Figure 2). To make maximum use of the data gathered during the field test, it is mandatory that the relative thermal stress characteristics and comfort of the two designs be evaluated. The U. S. Army Natick Research and Development Command and Research Institute of Environmental Medicine (ARIEM) have unique capabilities not available elsewhere to perform this comparative evaluation. This test program is designed to utilize these capabilities to develop relative data between the two designs to preserve the usefulness of the wear and comfort results obtained in the high cost field test program.

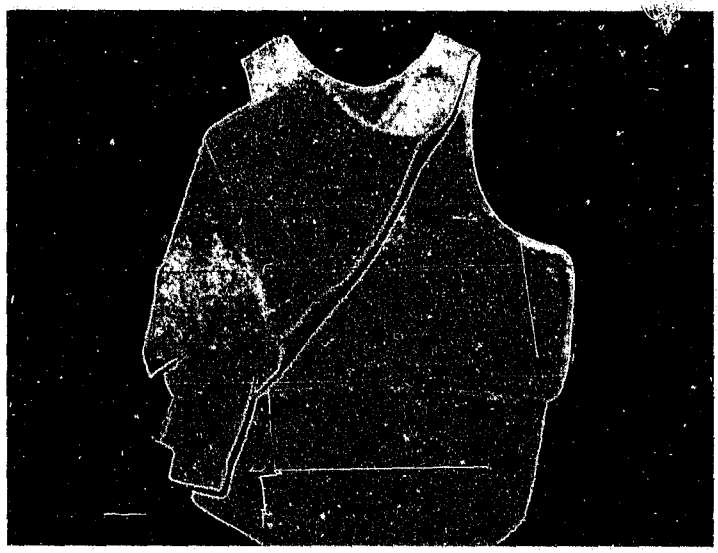


Figure 1. Armor Type A-1

Figure 2. Armor Type A-2 and A-3

2.0 TEST REQUIREMENTS

2.1 Test Responsibilities

In accordance with U.S. Army Material Development and Readiness Command (DARCOM) Regulation No. 70-20 the tests will be performed by personnel (including contract personnel if applicable) of Natick Research and Development Laboratories. The Aerospace Corporation personnel may witness the tests as observers. To enable Aerospace personnel to witness the test, if they so elect, a minimum of three working days notice will be provided by Natick. The Aerospace Corporation point of contact for these tests and related information is R. A. Merkle (202) 484-5500.

2.2 Instrumentation Systems

The instrumentation systems which will be used for this test series are the copper manikin and the anatomical load profile analyzer.

2.2.1 The Copper Manikin The copper manikin system comprises a hollow simulator constructed to the size of an average U. S. Army infantryman with thermocouples located at 21 representative sites on the skin. The copper skin is equipped with thermostatically controlled heating wires. Varying the thermostat setting to maintain skin temperature and measuring the power delivered to the heating wires, enables the heat loss through the skin to be determined. By performing tests in a controlled external environment with the copper skin dry, the insulating effect of clothing placed on the manikin may be determined. This technique is used to measure the insulation index (clo) of various garments.

By placing a cotton "skin" over the manikin, wetting it, and adjusting the system to equilibrium conditions (manikin and environmental chamber), impermeability index (i_m) is determined.

2.2.2 The Anatomical Load Profile Analyzer The Anatomical Load Profile Analyzer is a reticulated series of 248 miniature local sensors which covers the upper torso of an individual wearing the test garment.

A "3D" display unit is provided to visually display loads and pressure points. The system is capable of measuring and displaying pressure, pressure changes, load magnitude and distribution of forces transmitted to the torso by the garment as the test subject assumes a variety of positions.

2.3 Test Articles

2.3.1 LEAA Style I Field Test Garment The LEAA Style I garment is a joint LEAA/Natick/Aerospace design which was developed specifically for the field test program. It is an under-vest with complete wrap-around upper torso coverage. The garment is fitted over the head, open at the sides, with two one-inch adjustable velcro straps passing through buckles on each side for fit adjustment. Seven plies of 1000 denier Kevlar fabric are integrated into the garment with a poly-cotton outer covering and exposed on the inside. The Kevlar is Zepel treated. This garment has been designated A-1.

2.3.2 New Design Garments As a result of experience gained in the field test, certain design changes have been proposed and prototypes of garments with the new changes have been fabricated. The most significant difference between these prototypes and the test garment is that the ballistic material is contained in a separate insert which may be installed and removed from a carrier garment. Both garments have ballistic inserts containing seven plies of 1000 denier Kevlar enclosed in water resistant cloth covers. In one insert, the Kevlar fabric is Zepel treated while the other contains Kevlar which has only a scoured finish. These two test articles are designated A-2 and A-3.

2.4 Copper Manikin Tests

2.4.1 Test Setup In this series of tests, the most important factor is the relative performance among the three garments being tested.

Also, it is desirable, but not mandatory, to be able to have a point of comparison between these tests and work previously reported by U. S. Army on the body armor program (Reference 1). For all copper manikin test, in this series the following articles of clothing will be used:

a. Shirt, Police, short sleeve, Miami P.D., collar open
b. Trousers, Police, polyester, summerweight
c. Cap, Police, open-weave
d. Police belt with holster (containing 1.5 Kg weight), whistle, pen and pencil holder, double cartridge case, handcuffs
e. In trouser pockets: 12-inch billy, leather notebook, and flashlight with wand
f. Cushion sole socks and combat boots (U.S.Army items)

All tests will be performed in the environmental chamber.

The above articles will be furnished by the U. S. Army.

2.4.2 Insulation Index (clo) For the insulation index test series, the copper manikin will be dry. A form fitting cotton tee shirt skin will cover the entire manikin and the armors placed over this skin. The manikin will be clothed as identified in paragraph 2.4.1. A baseline set of measurements will be made without armor on the manikin at the specified chamber conditions. The test matrix shown in Figure 1 will be used:

Reference 1: Lightweight Body Armor for Law Enforcement Officers - National Institute of Law Enforcement and Criminal Justice, May 1976 - Government Printing Office Stock No. 027-000-00409-1

Figure 1: Insulation Index (clo) Matrix

Body Armor Type / Test Conditions	Manikin Skin Temperature (Normal)	Chamber Conditions T = 80°F RH - 50%
None	✓	✓
A-1	✓	✓
A-2	✓	✓
A-3	✓	✓

The insulation index measurements will be made when the system (manikin and chamber) reaches equilibrium.

2.4.3 Impermeability Index (^{i}m) For the impermeability index series the cotton skin will be wetted to simulate perspiration. The manikin will be clothed as identified in paragraph 2.4.1. A baseline set of measurements will be made without the armor on the manikin at the specified chamber conditions. The following matrix will be used.

Figure 2: Impermeability Index (^{i}m) Matrix

Body Armor Type / Test Conditions	Manikin Skin Temperature (Normal)	Chamber Conditions T = 80°F RH = 50%
None	✓	✓
A-1	✓	✓
A-2	✓	✓
A-3	✓	✓

The impermeability index measurements will be made when the system (manikin and chamber) reach equilibrium.

2.4.4 Water Absorption Tests This series of tests will be used to determine the amount of water absorbed by the three garments after prolonged exposure and with the manikin's skin wetted. The test setup will be the same as for 2.4.3. All three tests will be conducted in the same manner.

Prior to the start of the test and with the garments completely dry, weigh the armor and the uniform shirt. With the armor installed, the manikin skin wetted, and the system at equilibrium (manikin skin normal; chamber temperature and humidity at 80°F and 50 percent respectively) maintain conditions for five (5) hours. Immediately, remove shirt and armor and record weights of both. Also, record weight, if any, of any additional water added to each test setup.

2.5 Anatomical Load Distribution Analyzer Tests

2.5.1 Test Setup This series of tests will be conducted using the three garment types without outer shirts. The tester will don each garment over the load sensor network and assume a series of positions. The load sensor data will be recorded and the "3-D" display activated. The purpose of this series of tests is to determine pressure points and loading as a function of assumed positions.

2.5.2 Test Positions The following positions are required:

a. Standing - normal breathing
b. Standing - heavy breathing
c. Rifle firing - standing
d. Rifle firing - kneeling
e. Stooped over
f. Reaching up - both hands
g. Reaching to holster - right to right
h. Pistol firing - standing both hands forward

i. Pistol firing - crouched both hands forward

j. Pistol firing - standing one hand hold (arm forward, to side and 45° angle)

k. Sitting - straight

l. Sitting - leaning back

3.0 TEST REPORTS

The test reports shall be the minimum consistent with the exchange of data and results. The report shall be in letter format and contain as a minimum the following:

a. Raw data from each test series

b. Calculations of (clo) and (i_m) for the appropriate set of test conditions

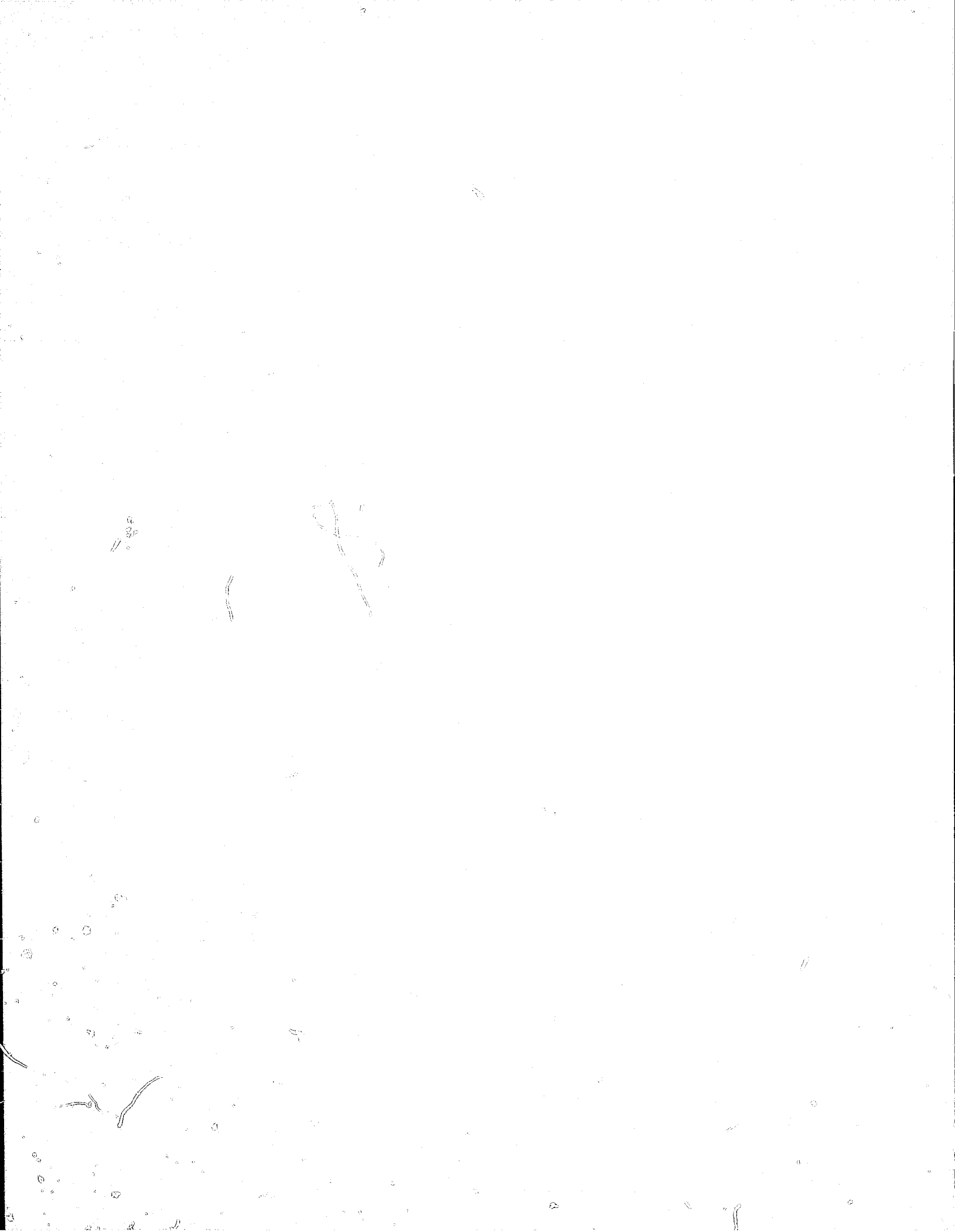
c. Load charts for the four zones from the load profile analyzer (upper front, lower front, upper rear, and lower rear)

d. Identification of any abnormally high load areas for any garment, any position

e. Analysis and interpretation of results

APPENDIX E

HIGH ENERGY THREAT ASSESSMENT



APPENDIX E. HIGH ENERGY THREAT ASSESSMENT

1. Law Enforcement Officer Fatalities

This analysis reassesses the issues associated with the so-called high energy handgun threats and their relationship to law enforcement officers and soft body armor. From 1973 to the present time, many things have happened within the program, the industry, and the law enforcement community which indicate a need to reassess the high energy handgun. This analysis presents the new data in terms of law enforcement officer fatalities as summarized in the FBI reports.

Table E-1 lists the caliber of handguns that were used in fatal assaults on law enforcement officers, as derived from the 1974 and 1975 summaries issued by the Federal Bureau of Investigation.

Table E-1. Law Enforcement Officer Fatalities

Weapon Caliber	1974	1975
.22	9	7
.25	3	3
7.65 mm	1	1
.32	7	8
.380	3	-
.38	44	48
.357 magnum	9	17
9 mm	4	4
.41 magnum		
.44 magnum		
.45	4	2
Not identified	5	1
Officer's own weapon	(11)	(19)
Total	89	91

The above total handgun fatalities differ slightly from the FBI Summaries due to differences in assignments when multiple wounds were reported. For example, the FBI reported 95 handgun-related fatalities in 1974 and 93 in 1975. The values in Table E-1 were extracted from the written summaries in the reports rather than the department inputs to the Bureau.

Figures E-1 and E-2 summarize the reported fatalities to law enforcement personnel from 1964 through 1975 which resulted from the use of high energy handguns. The data used represent 801 fatal handgun-related assaults, 138 being the result of high energy weapons, while 94 of those resulted from the .357 magnum or 9 mm projectile. Over the 11-year period covered, six fatalities were attributed to either .41 magnum or .44 magnum (three of each) weapons. Of those six, three were by the officer's own weapon. In summary, of the 801 fatalities reported, approximately 17 percent were related to the high energy handguns. Of these, 11.7 percent were related to the .357 magnum and 9 mm weapons and 0.7 percent to the .41 magnum and .44 magnum weapons. During the period from 1964 through 1971 (except for 1969), the high energy handgun-related fatalities averaged approximately 11 percent of the total. For the period between 1972 and 1975, the average fatality rate due to high energy handguns increased to more than 23 percent. For 1964 through 1971, the fatalities related to the 9 mm and .357 magnum weapons averaged 5.6 percent, while for the 1971 through 1975 time period, they averaged almost 20 percent of the total. In the past few years, there has been a significant increase in the percentage of high energy handguns, particularly the 9 mm and .357 magnum weapons, used in committing fatal assaults on law enforcement officers.

The other issue which should be addressed is the officer fatalities in which their own weapons are used. Figure E-3 shows the percent of officer fatalities in which their own weapons were employed against themselves. For the 12-year period between 1964 and 1975, an average of 15 percent of the law enforcement officers' fatalities were related to their own weapons. For the period between 1971 and 1975, the average was almost 20 percent. The loss of the officer's weapon has been a continuing threat; however, the

HIGH ENERGY HANDGUNS - .357 magnum, .45, .41 magnum, .44 magnum, 9 mm

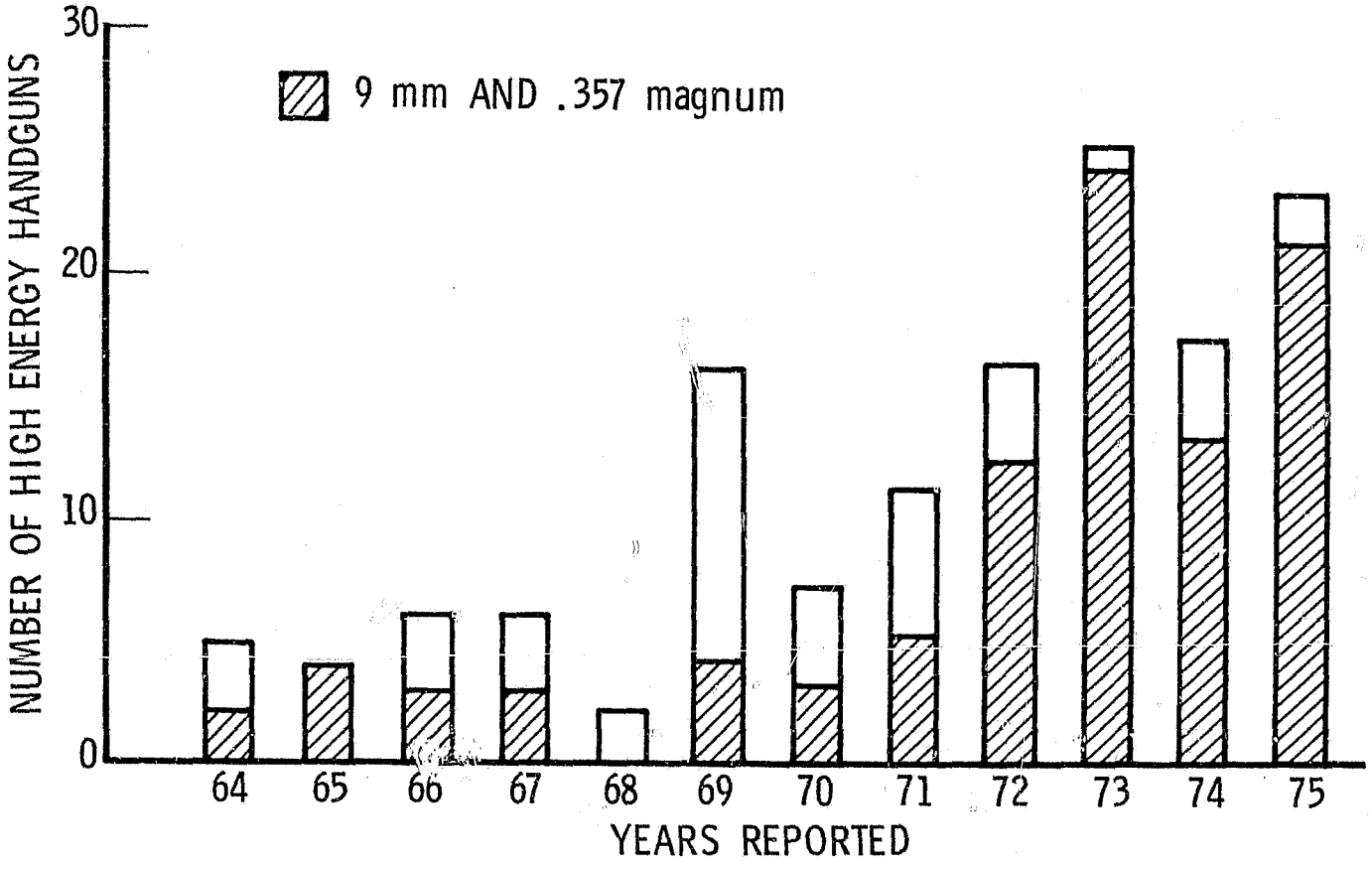


Figure E-1. Number of High Energy Handguns Used in Fatal Assaults on Law Enforcement Officers

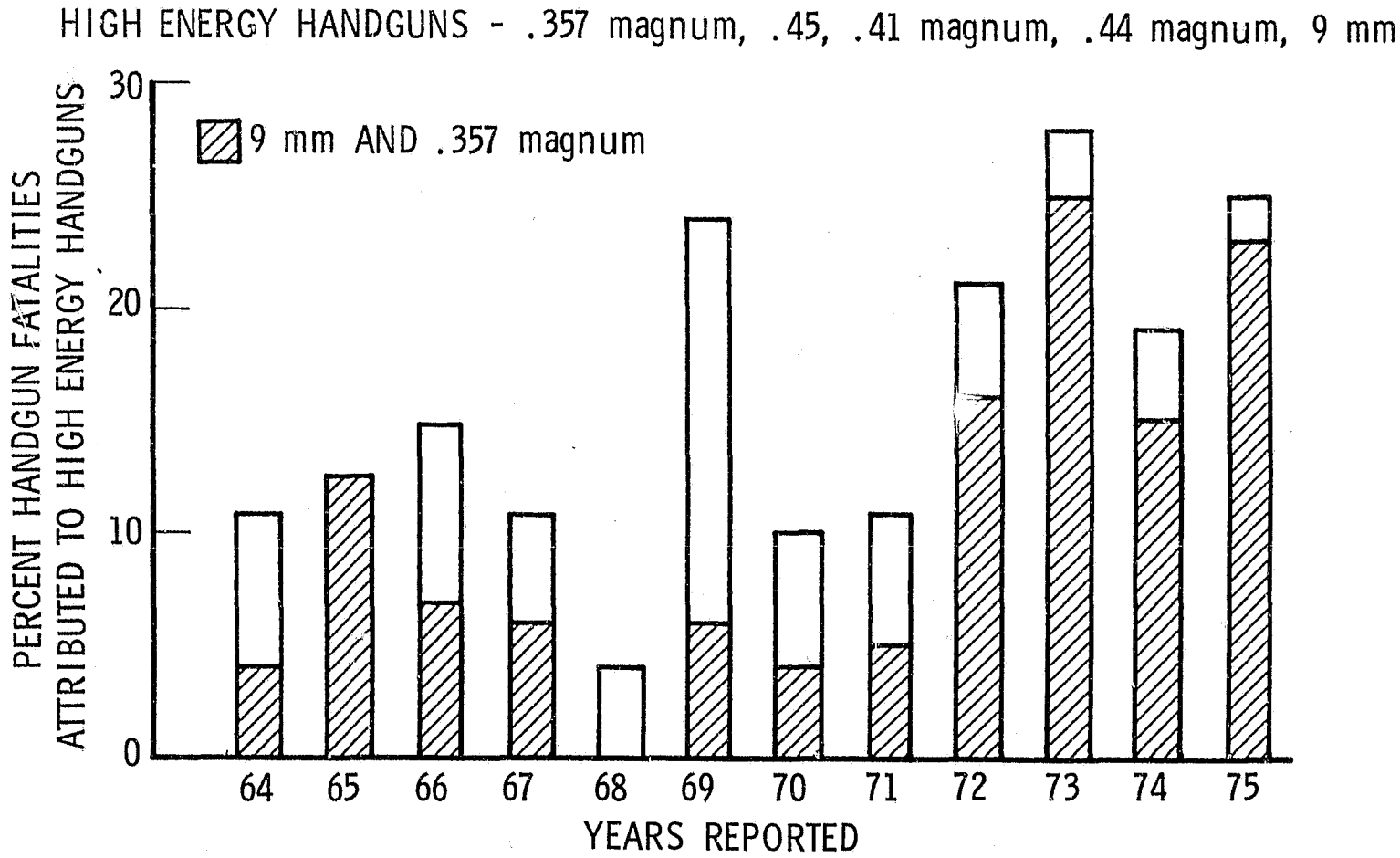


Figure E-2. Percent of High Energy Handguns Used in Fatal Assaults on Law Enforcement Officers

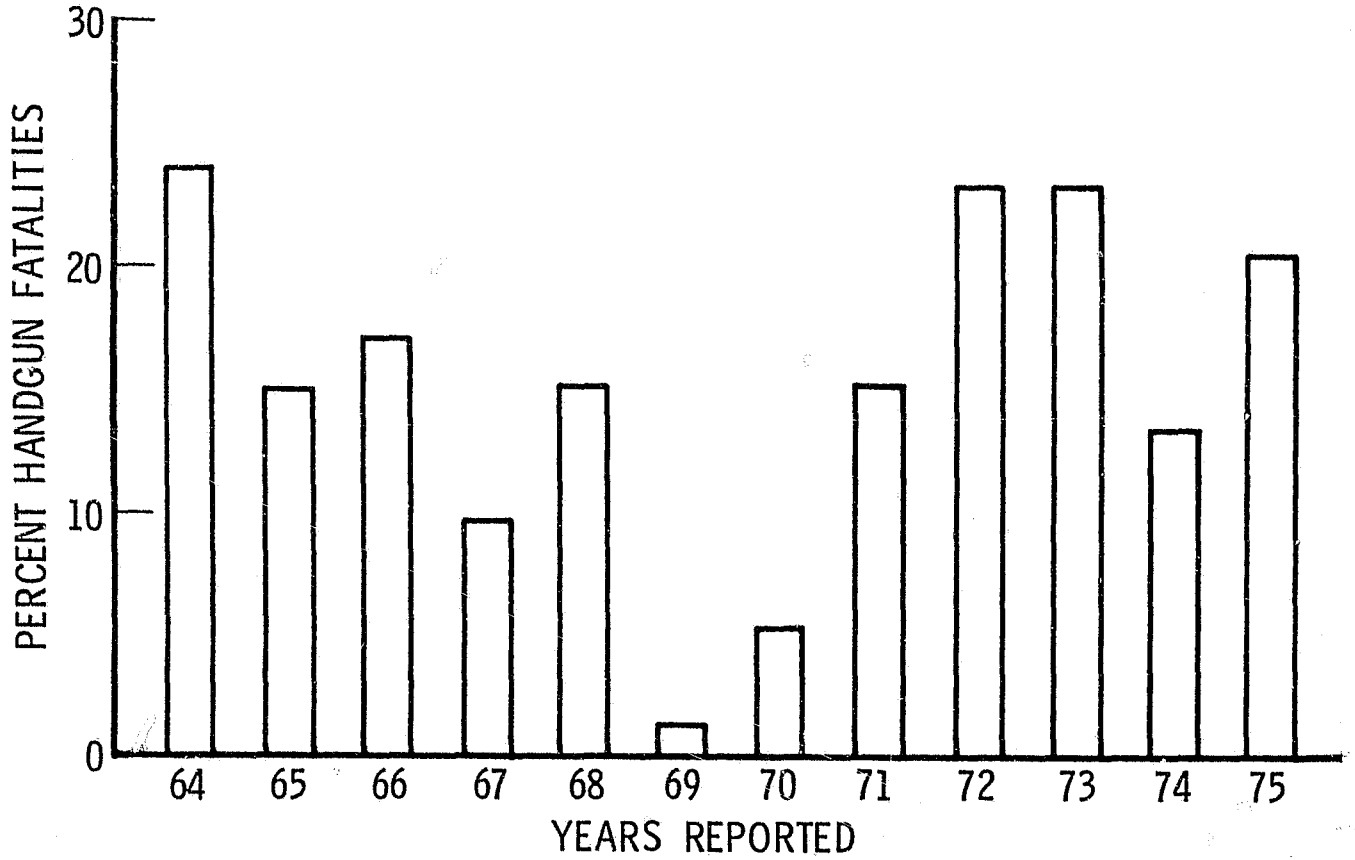


Figure E-3. Percent Law Enforcement Officer Handgun-Inflicted Fatalities Related to the Officer's Own Weapon

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1 OF 2

introduction in recent years of the high velocity .38 special ammunition and its adoption by the police departments has increased the seriousness of the problem. The high velocity ammunition in the officer's own weapon has made those weapons effectively high energy handguns.

On the basis of the above data, the following conclusions are suggested:

- The 9 mm and .357 magnum represent an increasing threat to the law enforcement officer.
- The 9 mm and .357 magnum are now a significant portion of the handgun threat.
- The .41 magnum and .44 magnum handguns are not a significant portion of the handgun threat.
- The officer's own weapon, when chambered with the high velocity .38 special round, becomes in essence a high energy weapon and adds significantly to that threat.

2. Confiscated Weapons Analysis

As part of the continuing data collection function within the Lightweight Body Armor Field Test Program, an effort was undertaken to update the confiscated weapons summary prepared by the International Association of Chiefs of Police (IACP) in 1971 and 1972. The purpose was to determine if there was a significant change in the distribution of confiscated weapons between 1971-1972 and 1975-1976. The results of this effort are presented in the following sections.

During the course of the test program, personal contacts and telephone interviews with representatives of the participating police departments revealed a concern by the departments in terms of the higher energy handguns. A number of departments made the observation that they were encountering the 9 mm automatic with increasing frequency. Comments were also made that the .357 magnum handgun was becoming more common on the streets. These comments were encountered most frequently on the west coast, southwest, and southeast portions of the country. This effort was initiated to determine if the increase in the higher energy handgun frequency was on a national scale and to obtain a numerical estimate of the change.

Although the specific details of the IACP study are not conveniently available, the results have been sufficiently documented that the detail necessary for comparison is available. The IACP survey encompassed a total of 18,500 firearms. The results are summarized in Table E-2.

Table E-2. IACP Confiscated Weapons Survey

(1971-1972)

Weapon Handguns (by caliber)	Percent Handguns	Percent Total Weapons
.22	36.6	30.0
.25	11.1	9.1
.32	16.5	13.5
.380	0.7	0.6
.38	29.4	24.5
.357 magnum	0.7	0.6
.45	2.4	2.0
9 mm	1.8	1.5
.44 magnum	0.2	0.2
Shotguns		18.0
Rifles		

From these data, the higher energy handguns (.357 magnum, .45, 9 mm, and .44 magnum) comprised 5.1 percent of the handguns and 4.3 percent of all the firearms in the sample.

In March 1977, the cities which were participating in the Body Armor Field Test Program were contacted and requested to provide summaries of the firearms confiscated by their personnel during 1975 and 1976. They were requested to include all firearms and to identify the handguns by caliber. An additional ground rule was that the data should be readily available from

their records. There was no intention to impose a significant work load on the departments to assemble the data. Of the fifteen participating departments, eleven responded with the requested data. Their responses covered 22,903 firearms, of which 18,489 were handguns. The data submitted by the departments are contained in Table E-3.

Table E-3. Confiscated Weapons Summary, Body Armor Field Test Data (1975-1976)

Weapon	Number	Percent Handguns	Percent All Firearms
Handgun (by caliber)			
.22	5,460	29.5	23.8
.25	1,601	8.7	7.0
7.65 mm	102	0.6	0.4
.32	2,731	14.8	11.9
.380	258	1.4	1.1
.38	6,501	35.2	28.4
.357	769	4.2	3.4
.45	452	2.4	2.0
9 mm	452	2.4	2.0
.41 magnum	43	0.2	0.2
.44 magnum	118	0.6	0.5
Total	18,489	100%	80.7
Shotguns			
Total	2,337		10.2
Rifles			
Total	2,077		9.1
Total	22,903		100%

From these data, the higher energy handguns (.357 magnum, .45, 9 mm, .41 magnum, .44 magnum) comprise 9.8 percent of the handguns and 8.1 percent of all the firearms in the sample.

Both sets of data indicate that the percentage of rifles and shotguns is about the same (18 percent for the IACP data and 19.3 percent for the body armor data sample), hence the relative distribution of confiscated handguns and long guns remained the same. The distribution between low energy (.38 special and lower calibers) and high energy handguns indicated a twofold increase in the percentage of high energy weapons. Based on the 1975-1976 data, one in ten handguns confiscated is now in the .45 to .44 magnum class of weapon. Within this category, the percentage factor increase for each of the calibers was:

.45 - no change

9 mm - increased by a factor of 1.3

.357 magnum - increased by a factor of 6

.44 magnum - increased by a factor of 4

These increases are significant for the 9 mm and .357 magnum weapons in that they now represent approximately 6.6 percent of the confiscated weapons. The increase in the .44 magnum and .41 magnum is not felt to be significant because they represent less than 1 percent of the handguns. In the body armor data sample, there were 43 handguns in the .41 magnum caliber and 118 in the .44 magnum caliber, for a total of 161 out of 18,489.

Figure E-4 summarizes the results of the two data sets for handguns only.

On the basis of the data available from these two data sets, the following conclusions are suggested:

- There has been a significant increase in the percentage of high energy handguns compared to the total handgun population from 1972 to 1976.
- The high energy handguns are now a significant portion of the total handgun population.
- The .41 magnum and .44 magnum handguns are not a significant portion of the population.

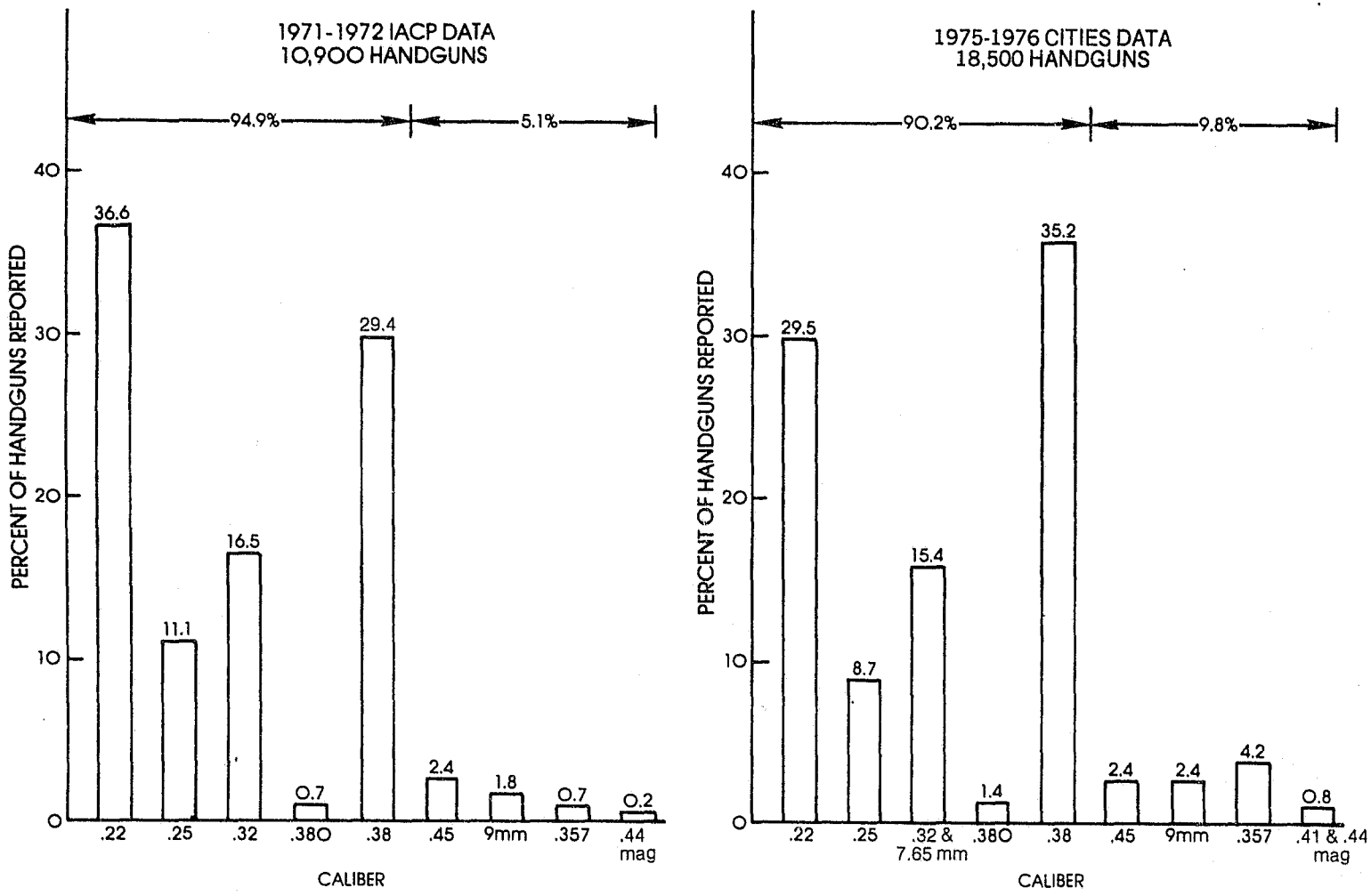

Figure E-4. Confiscated Handguns Comparison, 1971/1972 and 1975/1976

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