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Law Enforcement and Corrections Standards and Testing Program

TEST PROTOCOL FOR COMPARATIVE EVALUATION OF PROTECTIVE GLOVES FOR LAW ENFORCEMENT AND CORRECTIONS APPLICATIONS

NIJ TEST PROTOCOL 99-114

ABOUT THE LAW ENFORCEMENT AND CORRECTIONS STANDARDS AND TESTING PROGRAM

The Law Enforcement and Corrections Standards and Testing Program is sponsored by the Office of Science and Technology of the National Institute of Justice (NIJ), U.S. Department of Justice. The program responds to the mandate of the Justice System Improvement Act of 1979, which created NIJ and directed it to encourage research and development to improve the criminal justice system and to disseminate the results to Federal, State, and local agencies.

The Law Enforcement and Corrections Standards and Testing Program is an applied research effort that determines the technological needs of justice system agencies, sets minimum performance standards for specific devices, tests commercially available equipment against those standards, and disseminates the standards and the test results to criminal justice agencies nationally and internationally.

The program operates through:

The *Law Enforcement and Corrections Technology Advisory Council* (LECTAC) consisting of nationally recognized criminal justice practitioners from Federal, State, and local agencies, which assesses technological needs and sets priorities for research programs and items to be evaluated and tested.

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Publications are available at no charge from the National Law Enforcement and Corrections Technology Center. Some documents are also available online through the Internet/World Wide Web. To request a document or additional information, call 800-248-2742 or 301-519-5060, or write:

National Law Enforcement and Corrections Technology Center
P.O. Box 1160
Rockville, MD 20849-1160
E-Mail: *asknlectc@nlectc.org*
World Wide Web address: *http:www.nlectc.org*

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Test Protocol for Comparative Evaluation of Protective Gloves for Law Enforcement and Corrections Applications

NIJ Test Protocol 99-114

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This test protocol was formulated by the Office of Law
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National Institute of Standards and Technology (NIST)
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of this test protocol was sponsored by the
National Institute of Justice, David G. Boyd, Director,
Office of Science and Technology.

This test protocol has been reviewed and approved by the
Weapons and Protective Systems Subcommittee and the
Executive Committee of the Law Enforcement and
Corrections Technology Advisory Council.

FOREWORD

This document, **NIJ Test Protocol 99-114: Test Protocol for Comparative Evaluation of Protective Gloves for Law Enforcement and Corrections Applications**, is a comparative evaluation protocol developed by the Office of Law Enforcement Standards of the National Institute of Standards and Technology. It is produced as part of the Law Enforcement and Corrections Standards and Testing Program of the National Institute of Justice. A brief description of the program appears on the inside front cover.

This test protocol is a technical document that evaluates performance and other requirements that equipment should meet to satisfy the needs of criminal justice agencies for high-quality service. Purchasers can use the test methods described in this test protocol to evaluate whether a particular piece of equipment meets the agency's essential requirements, or they may have the tests conducted on their behalf by a qualified testing laboratory. NIJ, through its National Law Enforcement and Corrections Technology Center (NLECTC)– National, conducts periodic comparative evaluations of products in accordance with the test methods outlined in this protocol and publishes the data. These reports can be utilized by agencies to assist in selecting products that best meet their requirements. For copies of the most recent evaluations conducted, contact NLECTC at 800-248-2742 or 301-519-5060.

Because this NIJ test protocol is designed as a procurement aid, it provides precise and detailed test methods. For those who seek general guidance concerning the selection and application of law enforcement equipment, user guides have also been published. The guides explain in nontechnical language how to select equipment capable of the performance required by an agency.

NIJ test protocols are subjected to continuing review. Technical comments and recommended revisions are welcome. Please send suggestions to the Director, Office of Science and Technology, National Institute of Justice, U.S. Department of Justice, 810 7th St., NW, Washington, DC 20531.

Before citing this or any other NIJ test protocol in a contract document, users should verify that the most recent edition of the test protocol is used. Write to: Director, Office of Law Enforcement Standards, National Institute of Standards and Technology, 100 Bureau Drive, Stop 8102, Gaithersburg, MD 20899-8102.

David G. Boyd, Director
Office of Science and Technology
National Institute of Justice

NIJ TEST PROTOCOL
FOR
COMPARATIVE EVALUATION OF PROTECTIVE GLOVES FOR LAW ENFORCEMENT AND CORRECTIONS APPLICATIONS

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Commonly used Symbols and Abbreviations

A	ampere	H	henry	nm	nanometer
ac	alternating current	h	hr hour	No.	number
AM	amplitude modulation	hf	high frequency	o.d.	outside diameter
cd	candela	Hz	hertz (c/s)	Ω	ohm
cm	centimeter	i.d.	inside diameter	p.	page
CP	chemically pure	in	inch*		Pa pascal
c/s	cycle per second*	ir	infrared	pe	probable error
d	day	J	joule	pp.	pages
dB	decibel	L	lambert	ppm	part per million
dc	direct current	L	liter	qt	quart*
°C	degree Celsius	lb	pound*	rad	radian
°F	degree Fahrenheit*	lbf	pound-force*	rf	radio frequency
diam	diameter	lbfqin	pound-force inch*	rh	relative humidity
emf	electromotive force	lm	lumen	s	second
eq	equation	ln	logarithm (natural)	SD	standard deviation
F	farad	log	logarithm (common)	sec.	section
fc	footcandle*	*M*	molar	SWR	standing wave ratio
fig.	figure	m	meter	uhf	ultrahigh frequency
FM	frequency modulation	min	minute	uv	ultraviolet
ft	foot*	mm	millimeter	V	volt
ft/s	foot per second*		mph mile per hour*	vhf	very high frequency
g	acceleration	m/s	meter per second	W	watt
g	gram	N	newton	λ	wavelength
gr	grain*	Nqm	newton meter	wt	weight

area = unit^2 (e.g., m^2, cm^2, etc.); volume = unit^3 (e.g., m^3, cm^3, etc.)

PREFIXES

d	deci (10^{-1})	da	deka (10)
c	centi (10^{-2})	h	hecto (10^2)
m	milli (10^{-3})	k	kilo (10^3)
μ	micro (10^{-6})	M	mega (10^6)
n	nano (10^{-9})	G	giga (10^9)
p	pico (10^{-12})	T	tera (10^{12})

COMMON CONVERSIONS
(See ASTM E380)

ft/s × 0.3048000=m/s
ft × 0.3048=m
ftqlbf × 1.355818=J
gr × 0.06479891=g
in × 2.54=cm
kWh ×3600000=J
lb × 0.4535924=kg
lbf × 4.448222=N
lbf/ft × 14.59390=N/m
lbfqin × 0.1129848=Nqm
lbf/in^2 × 6894.757=Pa
mph × 1.609344=km/h
qt × 0.9463529=L

Temperature: $(T_{°F}-32)\times 5/9=T_{°C}$
Temperature: $(T_{°C}\times 9/5)+32=T_{°F}$

*These units are not in the metric system of units, but are included for the convenience of the user.

NIJ TEST PROTOCOL FOR COMPARATIVE EVALUATION OF PROTECTIVE GLOVES FOR LAW ENFORCEMENT AND CORRECTIONS APPLICATIONS

1. PURPOSE AND SCOPE

The purpose of this test protocol is to compare the performance of protective gloves for use by law enforcement, corrections, and military personnel. The scope of this test protocol is limited to the types of gloves that meet the rating levels described in Section 3.2 of this test protocol. The applicable documents, which are in Section 2.0, describe the test methods for conducting the comparative evaluation of the protective gloves and are incorporated as part of this test protocol.

2. APPLICABLE DOCUMENTS

2.1 Government Documents

The most current versions of the following referenced documents should be used.

Federal

Code of Federal Regulations (CFR)[1]

a. 29 CFR 1910 Part 1030	"Occupational Exposure to Bloodborne Pathogens: Final Rule," Federal Register, Vol. 56, No. 235, Dec. 6, 1991, pp. 64175-64182 (Occupational Safety and Health Administration).
b. 16 CFR Part 1500.3	Definitions of Toxic and Hazardous Materials.
c. 16 CFR 423, Part 423	Care Labeling of Textile Wearing Apparel and Certain Piece Goods, as amended effective January 2, 1984; Federal Trade Commission Regulation Rule.

[1]The CFR and Federal Register are for sale on a subscription basis by the Superintendent of Documents, U.S. Government Printing Office (GPO), Washington, DC 20402. Reprints of certain regulations may be obtained from the Federal Agency responsible for their issuance.

2.2 Non-Government Documents

The most current versions of the following referenced standards should be used.

2.2.1 American National Standards Institute (ANSI)/American Society for Quality Control (ASQC)[2]

ANSI/ASQC Z1.4	Sampling Procedures and Tables for Inspection by Attributes.

2.2.2 National Fire Protection Association (NFPA)[3]

NFPA 1999	Standard on Protective Clothing for Emergency Medical Operations.

2.2.3 American Society for Testing and Materials (ASTM)[4]

ASTM D 5151	Standard Test Method for Detection of Holes in Medical Gloves.
ASTM F 1671	Standard Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Blood-Borne Pathogens Using Phi-X174 Bacteriophage Penetration as a Test System.
ASTM F 1342	Standard Test Method for Protective Clothing Material Resistance to Puncture.
ASTM F 1790	Standard Test Method for Measuring Cut Resistance of Materials Used in Protective Clothing.
ASTM D 5712	Standard Test Method for Analysis of Protein in Natural Rubber and its Products.

[2]Copies may be obtained from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036, Standardization Documents Order Desk or from the American Society for Quality Control, 611 East Wisconsin Avenue, Milwaukee, WI 53202.

[3]Copies may be obtained from the National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

[4]Copies may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM D 2582	Standard Test Method for Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting.

2.2.4 British/European Standards[5]

BS EN 420:1994	General Requirements for Gloves.
BS EN 388:1994	Protective Gloves Against Mechanical Risks.

Table 1. Protective Glove Rating Matrix

Type>> **Criteria**	**A** **Pathogenic Resistant (Biohazard)**	**B** **Cut Resistant (Blade)**	**C** **Puncture Resistant (Needle)**
Pathogenic	**Pass**	**Pass/Fail/NT**	**Pass/Fail/NT**
Dexterity	**High/Moderate**	**Low/Moderate**	**Low/Moderate**
Tear	**High/Moderate**	**High/Moderate**	**High/Moderate**
Cut	**Rating/NT**	**High**	**High/Moderate/NT**
Puncture	**Rating/NT**	**High/Moderate/NT**	**High**

Notes for Table 1 Ratings:

a) Cut Resistance
   Low = Less than 5 N (<1.124 lbf)
   Moderate = 6 N to 15 N (1.349 lbf to 3.372 lbf)
   High = 16 N to 40 N (3.60 lbf to 8.99 lbf) or higher

b) Puncture Resistance
   Low = 20 N to 59 N (4.496 lbf to 13.264 lbf)
   Moderate = 60 N to 99 N (13.489 lbf to 22.257 lbf)
   High = 100 N to 150 N (22.482 lbf to 33.723 lbf) or higher

c) Tear Resistance
   Low = 10 N to 24 N (2.248 lbf to 5.396 lbf)
   Moderate = 25 N to 49 N (5.621 lbf to 11.016 lbf)
   High = 50 N to 75 N (11.241 lbf to 16.862 lbf) or higher

d) Dexterity
   Poor = can pick up only 11 mm diameter pins
   Low = can pick up only 9.5 mm diameter pins
   Moderate = can pick up 6.5 mm diameter pins
   High = can pick up 5 mm diameter pins

[5]Copies may be obtained from the Document Center, 1504 Industrial Way, Unit 9, Belmont, CA 94002-4044.

e) NT – Not tested (Gloves that are not claimed by the manufacturer as a given type of glove need not be tested against that Type Criteria, e.g., a cut resistant glove which is not claimed to be puncture resistant need not undergo a puncture test).

3. REQUIREMENTS

3.1 Description

The protective gloves covered by this test protocol are required to meet the performance criteria and rating types defined for each criterion in accordance with Table 1 on page 3.

3.2 Rating Types

There are three major rating types designated as Types A, B, and C. If technically and commercially feasible, a glove that combines all the performance requirements of types A, B, and C, is rated the highest.

3.2.1 Type A

This glove shall be specifically designed for protection against biological hazards. It shall provide general protection against health hazards in dealing with field interrogation, apprehension, transport, and incarceration of suspects and/or prisoners as well as crime scene investigation and evidence gathering.

3.2.2 Type B

This glove is specifically designed to be cut resistant. It shall provide general protection against health hazards in dealing with field interrogation, apprehension, and incarceration of suspects/prisoners as well as crime scene investigation and evidence gathering in hostile environments where sharp objects such as knives and razor blades may pose a threat.

3.2.3 Type C

This glove is specifically designed to be puncture resistant. It shall provide general protection against health hazards in dealing with field interrogation, apprehension, and incarceration of suspects/prisoners as well as crime scene investigation and evidence gathering in hostile environments where pointed and needle shaped objects may pose a threat. These gloves are intended for use while frisking or patting down suspects/ prisoners.

4. TEST METHODS

The performance criteria that the protective gloves in this test protocol are evaluated against are defined as follows:

4.1 Pathogenic Resistance

Pathogenic resistance gloves shall provide protection against common blood-borne infectious diseases. The gloves meeting this criterion shall provide protection against microbiological pathogens that are transmitted through physical contact or contact with bodily fluids, such as blood, saliva, semen, etc. The gloves shall form a barrier to both the pathogen and/or the carrier fluid when tested in accordance with NFPA 1999, Sections 6-9 and 6-10, and the ASTM Standards cited therein. The test method measures the resistance of a protective material to penetration by blood-borne pathogen and for leakage, using a surrogate microbe under conditions of continuous liquid contact. Protective clothing material pass/fail determination is based on the detection of viral penetration and/or glove leakage.

4.2 Dexterity

The gloves meeting this performance criterion shall meet the dexterity requirements when tested in accordance with British European Standard BS EN 420:1994, Section 5.2. In this test, a subject wearing the test glove is instructed to pick a series of pins of similar length but differing diameters. The dexterity is rated according to the smallest pin diameter that the subject wearing the glove can pick up.

4.3 Cut Resistance

The glove meeting this performance criterion shall provide protection against slashes and/or cuts by sharp objects, such as blades and knives when tested in accordance with ASTM F 1790. This test method is used to measure the cut resistance of a material when mounted on a mandrel and subjected to a cutting edge under a specified load.

4.4 Tear Resistance

The glove meeting this performance criterion shall provide the tear resistance when tested in accordance with British European Standard BS EN 388:1994, Section 6.3. In this method a tensile tester is used to measure the force necessary to tear a test specimen which is previously cut in a defined manner. For gloves that are entirely made of elastomeric materials such as plastic film, latex, etc., or have a liner made of such materials, the recommended test for tear resistance of the elastomeric material is ASTM D 2582. This test involves the determination of the dynamic tear resistance of plastic film and thin sheeting subjected to end-use snagging type hazards.

4.5 Puncture Resistance

The glove meeting this performance criterion shall be resistant to penetration by needles and other pointed objects when tested in accordance with ASTM F 1342. This test method determines the puncture resistance of a protective clothing specimen by measuring the force required to cause a sharp-edged puncture probe to penetrate through the specimen.

5. QUALITY ASSURANCE PROVISIONS

5.1 Responsibility for Inspection

The manufacturer shall be responsible for the performance of all inspection requirements as specified herein. Inspections and Quality Assurance procedures shall comply with ANSI/ASQC Z1.4, Sampling Procedures and Tables for Inspection by Attributes and OSHA Standard 29 CFR 1910.1030, Occupational Exposure to Blood-borne Pathogens: Final Rule, Federal Register, Vol. 56, No 235, Dec. 6, 1991, pp. 64175-64182. Except as otherwise specified, the manufacturer may use his/her own or any other facilities suitable for the performance of the inspection requirements specified herein.

5.2 Manufacturer Quality Assurance Plan

The manufacturer shall develop and institute a quality assurance plan in accordance with the standards listed in Section 4.l. This quality assurance plan shall ensure that the product delivered meets the requirements specified herein. Manufacturers should include a copy of this plan as part of any model shipped to the purchaser.

5.3 Examination Procedure

Lot numbers and results from the examination shall be recorded on the inspection sheets for each box of gloves. The sample and/or its components shall be examined for defects detailed in Section 6.3.

5.4 Test Procedures

Tests shall be performed in accordance with the following methods. Reference to specific instruments is for information only; use of a company and/or product name in this document does not imply approval or recommendation of the product in preference to others that may also be suitable. Test specimens for the cut (Sec. 4.3), tear (Sec. 4.4) and puncture (Sec. 4.5) tests shall be cut from the finished glove in accordance with the dimensions specified for each test method *and from glove location(s) specified in Figure 4, page 8 of BS EN Standard 388.* Fourteen (14) pairs of gloves are the minimum numbers of samples needed for each model submitted for testing. Twelve (12) pairs will be used for testing and two (2) pairs will be retained for archival purposes as indicated in Table 2 on page 7.

Table 2. Glove samples to be submitted for each model.

No.	Test Method	Minimum No. of Gloves to be Tested
1.	Pathogenic	4 Pairs
2.	Cut Resistance	2 Pairs
3.	Tear Resistance	4 Pairs
4.	Puncture Resistance	2 Pairs
5.	Archive	2 Pairs

5.4.1 Pathogenic Resistance

Tests for pathogenic resistance shall be as specified in Section 4.1.

5.4.2 Dexterity

The dexterity requirements of the gloves in this test protocol shall be tested as specified in Section 4.2

5.4.3 Cut Resistance

Tests for the cut resistance of the gloves shall be performed as specified in Section 4.3.

5.4.4 Tear Resistance

Tests for the tear resistance of the gloves shall be performed as specified in Section 4.4.

5.4.5 Puncture Resistance

Tests for the puncture resistance of the gloves shall be performed as specified in Section 4.5.

5.5 Reporting the Test Results

The laboratory results shall be summarized in a table format listing each glove model tested and how it performed against each of the performance criteria listed in Sections 4.1 to 4.5 of this test protocol. Statistical significance of the reported results as well as precision and accuracy of the test measurement shall also be reported, wherever it is deemed applicable.

6. WORKMANSHIP, LABELING, AND ACCEPTANCE REQUIREMENTS FOR PROTECTIVE GLOVES

6.1 Acceptance Criteria

A protective glove model satisfies the requirements of this test protocol if all sample items meet the workmanship (see Sec. 6.3) and labeling (see Sec. 6.4) requirements when tested in accordance with the performance requirements of this test protocol. Each manufacturer must submit a minimum of fourteen (14) pairs for each model for performance of the tests required for this protocol. Any sample found not in compliance with the workmanship and labeling requirements will be returned to the manufacturer, at the manufacturer's expense, without further testing.

6.2 Test Sequence

Tests shall be conducted in the order presented in Sections 4.1 through 4.5 of this test protocol. In the event that one of the samples fails to meet any requirement prior to the completion of testing, the laboratory shall continue with the test sequence, if possible, to the full completion of the performance requirements.

6.3 Workmanship

Each glove sample submitted shall be free from wrinkles, blisters, cracks, or fabric tears; incomplete, inconsistent, or unsecured stitching; sharp or rough edges or corners; and any other evidences of inferior workmanship. The gloves shall not tear nor shall the stitching unravel during inspection or while performing the tests specified in Sections 4.1 to 4.5. All samples of a given model must be identical in appearance, materials of construction, and manner of construction.

6.4 Labeling

Each set of protective gloves shall be clearly and durably marked (labeled) in a readable type size, in the English (U.S.) language, in accordance with the requirements set forth below. The label(s) must be securely attached to each glove. For nonfabric (latex) gloves providing basic pathogen protection, the manufacturer shall place the information required by this section on the box or as an insert to accompany the gloves in their intended packaging.

1. Name, logo, or other identification of the manufacturer.

2. The rated type of protection, according to Section 4.2 of this protocol and referenced to the current edition of this test protocol.

3. Size (if custom fitted, a provision for the name of the individual for whom it is made).

4. Lot number (a lot number is a control number assigned by the manufacturer to the lot of material used to construct the gloves, and should be used for traceability and quality control purposes).

5. Line to write "Date of Issue."

6. A model designation that uniquely identifies the glove for purchasing purposes. For the purposes of this test protocol, a "model" is defined as a manufacturer designation (name, number, or other description) that serves to uniquely identify a specific protective glove configuration based upon the details of the protective glove construction. Separate model designations must be assigned to protective gloves which vary in materials of construction (to include weave, denier, and waterproofing), manner of construction (to include stitch patterns or other methods of assembling the materials), and opening/closure configurations (i.e., hook and pile, zipper, elastic).

7. Care instructions for the gloves in accordance with 16 CFR 423, Part 423 *Care Labeling of Textile Wearing Apparel and Certain Piece Goods*, as amended effective January 2, 1984; Federal Trade Commission Regulation Rule [Not required for disposable or single-use gloves].

8. A statement indicating that each glove model submitted for testing has been tested for protein content in accordance with NFPA 1999, Section 6-15 and ASTM Test Method cited therein. This test method determines the protein content of the glove material(s) and reports the average protein content level in micrograms per gram of glove material(s).

7. CERTIFICATION OF TESTING IN ACCORDANCE WITH NIJ TEST PROTOCOLS

Manufacturers are prohibited from placing any statement on the model of protective glove (on the glove itself, the labeling, or accompanying advertisement or documentation) that in any way states, infers, or otherwise suggests that the model has been tested in accordance with the NIJ TEST PROTOCOL FOR PROTECTIVE GLOVES, until such time as the model has successfully completed testing at an NIJ-approved testing facility for the purposes of this test protocol, and a letter has been issued to the manufacturer by the National Law Enforcement and Corrections Technology Center (NLECTC). At that time, the manufacturer may place the following statement on the required labeling as specified in Section 6.4:

"The manufacturer certifies that this model of protective glove has been tested in accordance with NIJ Test Protocol 99-114, dated June 1999."

Manufacturers, once authorized to use this statement, are prohibited from modifying this statement in any fashion.