National Law Enforcement and Corrections Technology Center

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A Comparative Evaluation of Protective Gloves for Law Enforcement and Corrections Applications

Protective gloves are an important part of the standard personal protective equipment law enforcement and corrections officers should wear to avoid risks from blood-borne pathogens, including hepatitis or human immunodeficiency virus (HIV); from sharp-edged weapons such as knives or razor blades; and from pointed weapons such as hypodermic needles. There are a number of gloves on the market that claim to offer various levels of protection against some or all of these threats, but until now there has been no objective evaluation of their protective quality and no way to compare the performance of one manufacturer's glove against another's. Research on protective gloves has centered primarily on medical or industrial applications, with little focus on the particular needs of law enforcement and corrections professionals.

In response to a request from the Law Enforcement and Corrections Technology Advisory Council (LECTAC) to assist the law enforcement and corrections community in acquiring better protective gloves, the Office of Science and Technology of the National Institute of Justice (NIJ) assembled a team from the National Law Enforcement and Corrections Technology Center (NLECTC), the Office of Law Enforcement Standards (OLES), and the Office of Law Enforcement Technology Commercialization to develop a comparative evaluation protocol and a testing program for protective gloves. More information on the development of this test protocol can be found at the end of this bulletin.

NLECTC's advisory board, LECTAC, is composed of nationally recognized criminal justice practitioners from Federal, State, and local agencies who assess technological needs and set priorities for research programs and products to be evaluated and tested. NLECTC, a program of NIJ, supervises national comparative evaluation and standards-based testing programs that are conducted by independent laboratories. An important part of NLECTC's mission is to provide objective, independent testing of products to assist law enforcement and corrections agencies to procure safe, reliable equipment.

For most law enforcement and corrections products, there are no independent evaluation mechanisms or performance standards. OLES works closely with NLECTC to develop specific test protocols and evaluation methods that are used to test equipment. The most well known of the standards-based testing programs is the body armor program, but OLES has developed more than 200 standards for various types of law enforcement and corrections equipment, including rechargeable batteries, handcuffs, and pistols.

In addition to standards-based testing, NLECTC also manages comparative evaluation programs. For example, NIJ has a partnership with the Michigan State Police to test patrol vehicles. NIJ helps to underwrite costs and, in turn, disseminates testing data. Patrol vehicle tires and brake pads are also tested in a similar manner. For more information on NLECTC's testing programs, visit NLECTC's Internet site, JUSTNET, at www.justnet.org, or visit the testing program information pages at http://testingprogram.nlectc.org.

The Protection Classes

NIJ Test Protocol 99–114 establishes three major rating types for protective gloves, designated as Type A, pathogenic resistant (against biohazards); Type B, cut resistant (against blades); and Type C, puncture resistant (against hypodermic needles). Gloves that are considered to provide multiclass protection offer any combination of classes A, B, and/or C.

Type A is specifically designed for protection against biological hazards. The gloves should provide general protection against health hazards in the following situations: field interrogation, apprehension, transport, and incarceration of suspects and/or prisoners; crime scene investigation; and evidence gathering. Type A gloves are tested for pathogenic resistance, dexterity, and tear resistance. Puncture resistance and cut resistance may also be tested depending on the manufacturer's claims for a particular glove.

Type B is specially designed to be cut resistant. This type of glove should provide general protection against health hazards in the following situations: field interrogation, apprehension, and incarceration of suspects and/or prisoners; crime scene investigation; and evidence gathering in hostile environments where sharp objects such as knives and/or razor blades may pose a threat. Type B gloves are tested for dexterity, tear resistance, and cut resistance. Pathogenic resistance and puncture resistance may also be tested depending on the manufacturer's claims for a particular glove.

Type C is specifically designed to be puncture resistant. The gloves should provide general protection against health hazards in the following situations: field interrogation, apprehension, transport, and incarceration of suspects and/or prisoners; crime scene investigation; and evidence gathering in hostile environments where pointed and/or needle-shaped objects may pose a threat. These gloves are intended for use while frisking or patting down suspects and/or prisoners.

Type C gloves are tested for dexterity, tear resistance, and puncture resistance. Pathogenic resistance and cut resistance may also be tested depending on the manufacturer's claims for a particular glove. Table 1 shows the classifications of gloves and how they are rated.

In the spring of 2000, protective glove manufacturers were invited to submit models of protective gloves for testing in accordance with the requirements of *NIJ Test Protocol 99–114*. Nine manufacturers submitted a total of 28 glove models to be tested. Two laboratories, Touchstone Research Laboratory, located in Triadelphia, West Virginia, and TRI/Austin, Inc., located in Austin, Texas, were selected and approved to perform the testing. The gloves were tested between September 2000 and April 2001 at the approved test laboratories and the preliminary data were reviewed by NLECTC and OLES staff. This bulletin provides a summary review of that data and the test procedures, as well as an overview of some of the issues that a law enforcement or corrections agency must consider when selecting a particular type of protective glove.

How To Use This Bulletin

The NIJ test protocol for protective gloves is a comparative evaluation protocol that can be used as a procurement aid. Law enforcement and corrections agencies can use these ratings to evaluate and compare the performance of particular glove models, focusing on the tests that are applicable to individual department needs. It is important to note, however, that the rating scales of the specific test protocols were designed to test a wide range of protective materials and clothing, including cotton and nylon, for a wide range of industrial applications. Many

Table 1 **Protective glove rating**

Type	A: Pathogenic resistant (biohazard)	B: Cut resistant (blade)	C: Puncture resistant (needle)
Criteria			
Pathogenic	Pass	Pass/Fail/Not Tested	Pass/Fail/Not Tested
Dexterity	High/Moderate	Low/Moderate	Low/Moderate
Tear	High/Moderate	High/Moderate	High/Moderate
Cut	Rating/Not Tested	High	High/Moderate/Not Tested
Puncture	Rating/Not Tested	High/Moderate/Not Tested	High

Table 2 **Sample weighting factors**

Test	Points*
Dexterity	15
Pathogen protection	25
Puncture propagation (Latex gloves) -or-	10
Tear resistance (materials other than latex)	
Cut resistance	25
Puncture resistance	25
Total	**100**

*The sum of all categories must equal 100.

of the fibers used in protective gloves are similar to the fibers used to make ballistic- and stab-resistant protective vests. Because these fibers have tensile strengths many times higher than steel, the test results are skewed to the high end of the rating scales, sometimes extending beyond the parameters of the High rating.

Because performance requirements and needs may vary greatly between agencies, the information presented in this bulletin makes no attempt to identify which glove models performed best in either a specific category or as an overall test result across multiple categories. It is important that your agency place the appropriate weights on those portions of the test data most representative of the protection requirements determined to be essential to your agency's needs. A sample distribution of category weights is shown in table 2.

The test results reported in this bulletin may be used in two ways. First, they may be used as is to determine the model of protective gloves that best meet the needs of your agency. In this case, you should emphasize those portions of the evaluation that best reflect your agency's protection requirements. Second, the overall test results may be used to adjust the manufacturer's bid price for these glove models. In each test category, the absolute difference between a glove model and the best scoring glove model is divided by the best glove model's score, resulting in a deviation factor. This factor is then multiplied by a category weight, such as those listed in table 2, to produce a weighted category score. The total of these weighted scores for a particular glove model is then used to adjust the glove's bid price.

Testing Procedures and Methods

Pathogenic Resistance

Pathogen-resistant gloves provide protection against common bodily fluid-borne infectious diseases. Gloves that meet this criterion must provide protection against microbiological pathogens that are transmitted through physical contact or contact with bodily fluids, such as blood, saliva, or semen. The gloves are tested in accordance with *NFPA 1999, Sections 6–9 and 6–10, the Standard of Protective Clothing for Emergency Medical Operations; ASTM D5151, Standard Test Method for Detection of Holes in Medical Gloves;* and *ASTM F1671, 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*.

Pathogen-resistant gloves need to have excellent barrier characteristics that will be maintained under a variety of conditions. The test to detect for holes in gloves is a pass/fail test in which gloves are filled with water, suspended for 2 minutes, and visually inspected for leaks.

The test method to measure the resistance of a protective material to penetration by a bodily fluid-borne pathogen is performed by placing a glove sample, partially filled with a sterile liquid, into a flask that contains a broth that has been contaminated with a synthetic "Phage," or viral simulant. The cuff of the glove is rolled over the outer edge of the flask and the glove is filled with more uncontaminated liquid. The top of the flask is sealed with a paraffin film, placed on an orbital shaker in a heated incubator, and shaken for 1 hour. At the end of the hour, the flask is removed from the incubator and the paraffin film is removed. Several samples of the liquid from inside the glove are placed onto culture dishes, which are maintained in the incubator for a period of 6 to 18 hours. The cultures are analyzed to determine if any of the viral simulant penetrated the glove material and contaminated the liquid in the glove. As this test is a pass/fail criteria, any indication of viral penetration constitutes a failure. Table 3 shows the results of the pathogen-resistance test.

Dexterity

Dexterity testing is based on the dexterity requirements of the *British European Standard BS EN 420: 1994, Section 5.2, General Requirements for Gloves*. In this test, a subject wearing the test glove attempts to pick up a series of pins that have similar lengths but different diameters. The dexterity rating, which is expressed as High, Moderate, or Low, is based on the smallest diameter pin that can be picked up while wearing the glove. Table 4 shows the results of the dexterity test.

Table 3 **Results of pathogen-resistance test**

Manufacturer	Model	Pathogen resistance
HIGH FIVE	L902	Pass
HIGH FIVE	L972	Pass
HIGH FIVE	N803	Pass
Microflex	Diamond Grip Plus	Pass
Microflex	NeoPro ER	Pass
Microflex	Safegrip	Pass
Microflex	Synetron	Pass
Microflex	UltraOne	Pass
Microflex	UltraOne Plus	Pass
SAFESKIN	NITRILE (Synthetic Material)	Pass
SAFESKIN	NITRILE (Synthetic Co-Polymer)	Pass
SAFESKIN	PFE	Pass
SAFESKIN	PFE–XTRA	Pass
SAFESKIN	Satin Plus	Pass
Multilevel gloves:		
International Security Protection AS	SL–002 (with Kevlar)	Fail [a]
Spieth & Wensky (Dist. by Masley Enterprises, Inc.)	BGS–2000	Fail [a]
Samco Gloves	Multiprotective Frisk	Fail [a]

[a] = Due to the construction of these gloves, they were subjected to a preliminary test by partially filling the inside of the glove with water. Seepage developed in the seam areas of the fingers of all these models. Consequently, pathogen tests were conducted on only two gloves from each model.

Table 4 **Results of dexterity test**

Manufacturer	Model	Protection type	Dexterity BS EN 420
HIGH FIVE	L902	A (Pathogen Resistant)	High
HIGH FIVE	L972	A (Pathogen Resistant)	High
HIGH FIVE	N803	A (Pathogen Resistant)	High
Microflex	Diamond Grip Plus	A (Pathogen Resistant)	High
Microflex	NeoPro ER	A (Pathogen Resistant)	High
Microflex	Safegrip	A (Pathogen Resistant)	High
Microflex	Synetron	A (Pathogen Resistant)	High
Microflex	UltraOne	A (Pathogen Resistant)	High
Microflex	UltraOne Plus	A (Pathogen Resistant)	High
SAFESKIN	NITRILE (Synthetic Material)	A (Pathogen Resistant)	High
SAFESKIN	NITRILE (Synthetic Co-Polymer)	A (Pathogen Resistant)	High
SAFESKIN	PFE	A (Pathogen Resistant)	High
SAFESKIN	PFE–XTRA	A (Pathogen Resistant)	High
SAFESKIN	Satin Plus	A (Pathogen Resistant)	High
Damascus	DS20	B (Cut Resistant)	High
Damascus	DS1000	B (Cut Resistant)	High
Damascus	DS2000	B (Cut Resistant)	High
Damascus	DS3000	B (Cut Resistant)	High
Damascus	DS3500	B (Cut Resistant)	High
Damascus	LD800	B (Cut Resistant)	Moderate
Damascus	LD2000	B (Cut Resistant)	Moderate
Damascus	LDK300	B (Cut Resistant)	High
Warwick Mills	SAM–006	B (Cut Resistant)	Moderate
Warwick Mills	TCC–004	B (Cut Resistant)	Low
Gimbel Glove Company	Puncture Resistant w/Palm Pad (Catalog # 54080)	C (Puncture Resistant)	Moderate
International Security Protection AS	SL–002 (with Kevlar)	A, B, C	High
Spieth & Wensky (Dist. by Masley Enterprises, Inc.)	BGS–2000	A, B, C	High
Samco Gloves	Multiprotective Frisk	A, B, C	Moderate

Cut Resistance

The cut-resistance test measures the protection provided against slashes and/or cuts by sharp objects such as razor blades or knives. The test is based on *ASTM F1790, Standard Test Method for Measuring Cut Resistance of Materials Used in Protective Clothing.* In this test, the glove material is mounted on the metal mandrel of a cut tester. A special blade is moved across the specimen until it cuts through the material. Different weights are used on the arm holding the blade. The device measures the distance of blade travel before it cuts through the material, which is determined by when the blade makes contact with the mandrel. The fabric is rated as having High, Moderate, or Low cut resistance based on the weight needed to cut through the fabric. Table 5 shows results of the cut-resistance test.

Tear Resistance

The tear-resistance test is based on the *British European Standard BS EN 388: 1994, Section 6.3, Protective Gloves Against Mechanical Risks.* For this test, a computer-controlled tensile tester is used to measure the force necessary to tear a material specimen that has been taken from the glove. A 4-inch by 2-inch sample is cut from the glove and a 2-inch incision is made in the longitudinal (lengthwise) direction of the sample. The sample is mounted in the tensile tester, which records the force values required to completely tear the sample in two.

The test is performed on four different specimens, each one cut from a different glove. Two specimens are tested in the direction of the glove from cuff to finger tips, and two specimens are tested across the palm width. The tear resistance for each specimen is taken as the highest peak value recorded during the tests, and the classification is determined by taking the lowest of the four values. Based on these values, the tear resistance of the glove is rated as either High, Moderate, or Low. If a glove is made from several different types of materials that are not completely bonded together (e.g., a leather outershell with a cut-resistant insert), the test is performed on each layer, and the classification is based on the material that provides the highest level of cut resistance. Table 6 shows the results of the tear-resistance test.

For gloves that are entirely made of elastomeric materials (e.g., latex or plastic film) or have a liner of these

Table 5 **Results of cut-resistance test**

Manufacturer	Model	Cut (Reference Force) (mean, lbf)	std. dev.	rating
Damascus	DS20	1.07	0.09	Low
Damascus	DS1000	1.85 [a]	0.03	Moderate
Damascus	DS2000	1.23	0.09	Moderate
Damascus	DS3000	1.76	0.22	Moderate
Damascus	DS3500	2.46	0.34	Moderate
Damascus	LD800	0.62	0.01	Low
Damascus	LD2000	1.35	0.15	Moderate
Damascus	LDK300	1.10	0.08	Low
Warwick Mills	SAM–006	4.31 [b]	0.16	High
Warwick Mills	TCC–004	4.01 [c]	0.21	High
Multilevel gloves:				
International Security Protection AS	SL–002 (with Kevlar)	14.32	1.10	High
Spieth & Wensky (Dist. by Masley Enterprises, Inc.)	BGS–2000	1.90	0.08	Moderate
Samco Gloves	Multiprotective Frisk	1.05	0.03	Low

[a] = The Damascus DS1000 glove consisted of two separate layers. The outer (leather) layer had a reference force value of 0.265 lbf (1.18*N*).
[b] = The Warwick Mills SAM–006 glove contained stitching in the palm area. The reference force value across the stitch area was 2.625 lbf (11.68*N*) (moderate resistance).
[c] = The Warwick Mills TCC–004 glove consisted of two separate layers. The outer (leather) layer had a reference force value of 0.600 lbf (2.67*N*) (low resistance). This glove also had stitching around the thumb but did not extend to the palm. Cut tests were not conducted in the stitching because this area could not be positioned on the test fixture.

Cut resistance:
Low = Less than 1.124 lbf (< 5 *N*).
Moderate = 1.349 lbf to 3.373 lbf (6 *N* to 15 *N*).
High = 3.60 lbf to 8.99 lbf (16 *N* to 40 *N*) or higher.

materials, the test for tear resistance is *ASTM D2582, Standard Test Method for Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting*. This test method is designed to simulate material snagging and subsequent tearing caused by contact with sharp objects, for example, when a glove comes into contact with a protruding nail or hypodermic syringe. In this method, a probe is dropped by a carriage onto the surface of the test material that is held in a specimen holder at an angle to the probe. The tear resistance is calculated from the weight of the carriage, the height of the carriage before release, and the length of the resulting tear.

Four, 8-inch-long samples, each cut from a different glove, are individually mounted in a test fixture and held in place by five clamps. A sharp-edged probe is mounted onto a weighted drop mass, which falls along guide rails. This mass is dropped so that the probe comes in contact with the sample, causing it to tear. The weight of the mass is adjusted until the drops produce a tear that is 40 mm (1.57 inches) in length on the sample. The data is recorded for each sample, and the results are expressed as the average of the tear resistance for the direction tested. To determine the best score between gloves, the combination of the highest drop mass (carriage) weight and the highest resistance (lbf) determine which glove has the highest puncture-propagation resistance. Table 7 shows the results of this test.

Puncture Resistance

The puncture-resistance test is based on *ASTM F1342, Standard Test Method for Protective Clothing Material Resistance to Puncture*. The test method determines the puncture resistance of protective clothing by measuring the force required to cause a sharp-edged puncture probe to penetrate the material.

For this test, four specimens, each 4 inches square, are cut from separate gloves. Each sample is mounted into a holder that measures 3.5 inches in diameter, with three holes that are 1-inch apart at 60-degree angles, forming an equilateral triangle on the sample. The holder is mounted into a computer-controlled tensile tester and held in place with two bolts. A puncture probe is mounted in the test machine. The test machine records the force required to puncture the test sample at each of the three locations on the holder. All 12 data points are averaged to determine the final score. This score is then expressed in a rating scale as either

Table 6 **Results of tear-resistance test**

Manufacturer	Model	Tear (Transverse) (mean, lbf)	Tear (Transverse) std. dev.	Tear (Transverse) rating	Tear (Longitudinal) (mean, lbf)	Tear (Longitudinal) std. dev.	Tear (Longitudinal) rating
Cut-only gloves:							
Damascus	DS20	21.27	1.83	High	21.30	0.33	High
Damascus	DS1000	18.20	2.50	High	17.90	1.36	High
Damascus	DS2000	73.97	2.27	High	76.83	3.77	High
Damascus	DS3000	79.50	4.10	High	84.90	5.85	High
Damascus	DS3500	46.23	6.46	High	48.67	1.12	High
Damascus	LD800	8.30	0.70	Moderate	5.60	0.80	Low
Damascus	LD2000	75.60	4.90	High	78.40	6.44	High
Damascus	LDK300	20.20	1.12	High	24.31	6.09	High
Warwick Mills	SAM–006	9.00	0.30	Moderate	15.30	1.36	High
Warwick Mills	TCC–004	8.80	0.70	Moderate	13.50	1.19	High
Puncture-only gloves:							
Gimbel Glove Company	Puncture Resistant w/Palm Pad (Catalog # 54080)	48.31*	4.37	High*	35.38*	0.69	High*
Multilevel gloves:							
International Security Protection AS	SL–002 (with Kevlar)	44.60	5.60	High	39.60	3.18	High
Spieth & Wensky (Dist. by Masley Enterprises, Inc.)	BGS–2000	NT	NT	NT	NT	NT	NT
Samco Gloves	Multiprotective Frisk	71.90	10.50	High	85.10	8.25	High

*Glove consists of two layers (leather, woven aramid). The woven aramid layer produced higher ratings than the leather layer, so results reported are for the woven aramid layer.

Tear resistance:
Low = 2.248 lbf to 5.396 lbf (10 *N* to 24 *N*).
Moderate = 5.621 lbf to 11.016 lbf (25 *N* to 49 *N*).
High = 11.241 lbf to 16.862 lbf (50 *N* to 75 *N*) or higher.
NT = Not Tested

High, Moderate, or Low puncture resistance. Table 8 shows the results of this test.

Summary of Test Results

Under rating type A, or pathogen-resistant protective gloves, 14 models were tested. All 14 models passed the pathogen-resistance test and all 14 rated High for dexterity. The tear-resistance (puncture propagation) test results are listed in table 7.

Ten models of type B, or cut-resistant gloves, were tested. Six models rated High for dexterity, three rated Moderate, and one rated Low. The test for cut resistance resulted in two High ratings, five Moderate, and three Low. Under tear-resistance testing, seven models rated High in both transverse and longitudinal tear testing, two models rated High in longitudinal testing and Moderate in the transverse test, and one model rated Low in longitudinal testing and Moderate in the transverse test.

One model of type C, or puncture-resistant gloves, was tested. It rated Moderate for dexterity, High for puncture resistance, and High in both longitudinal and transverse tear testing.

In the multiclass category, three models of gloves that claimed to protect against type A, B, and C threats were tested. All three failed the test for pathogen

Table 7 **Results of puncture-propagation test**

			Puncture propagation ASTM D2582	
Manufacturer	**Model**	**Protection type**	Carriage Wt.	Resistance (lbf)
HIGH FIVE	L902	A (Pathogen Resistant)	0.1134	1.40
HIGH FIVE	L972	A (Pathogen Resistant)	0.1134	1.40
HIGH FIVE	N803	A (Pathogen Resistant)	0.2268	2.81
Microflex	Diamond Grip Plus	A (Pathogen Resistant)	0.1134	1.40
Microflex	NeoPro ER	A (Pathogen Resistant)	0.1134	2.44
Microflex	Safegrip	A (Pathogen Resistant)	0.1134	2.11
Microflex	Synetron	A (Pathogen Resistant)	0.2268	2.81
Microflex	UltraOne	A (Pathogen Resistant)	0.1134	2.51
Microflex	UltraOne Plus	A (Pathogen Resistant)	0.2268	2.67
SAFESKIN	NITRILE (Synthetic Material)	A (Pathogen Resistant)	0.1134	3.40
SAFESKIN	NITRILE (Synthetic Co-Polymer)	A (Pathogen Resistant)	0.1134	2.10
SAFESKIN	PFE	A (Pathogen Resistant)	0.1134	1.40
SAFESKIN	PFE-XTRA	A (Pathogen Resistant)	0.1134	1.40
SAFESKIN	Satin Plus	A (Pathogen Resistant)	0.1134	1.40

Table 8 **Results of puncture-resistance test**

		Thickness*	**Puncture force**		**Deflection**
Manufacturer	**Model**	(mean, mm)	rating	(mean [lbf])	(mean, mm)
Puncture-only gloves:					
Gimbel Glove Company	Puncture Resistant w/ Palm Pad (Catalog # 54080)	0.097	High	46.5 lbf	0.21
Multilevel gloves:					
International Security Protection AS	SL–002 (with Kevlar)	1.86	High	25.5 lbf	0.26
Spieth & Wensky (Dist. by Masley Enterprises, Inc.)	BGS–2000	1.11	High	29.1 lbf	5.08
Samco Gloves	Multiprotective Frisk	0.51	Low	10.4 lbf	5.08

*Thicknesses were measured with all layers and are approximate.

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

resistance because of infiltration through the stitching holes in the seams of the gloves. Two models rated High for dexterity and one rated Moderate. For cut resistance, one model rated High, one rated Moderate, and one rated Low. Two models rated High for puncture resistance and one model rated Low.

Selecting Protective Gloves

Note: The information contained in this section was developed from various sources, which are noted accordingly and include the University of Toronto Protective Glove Standard (http://www.utoronto.ca/safety/glovestd.htm).

In its 1999 standard, the National Fire Protection Association (NFPA) specified that emergency medical services (EMS) gloves must pass viral penetration, rubber flexibility, puncture, and dexterity testing. For a glove to be NFPA approved for EMS use, it must be flexible, fit well, have a degree of puncture resistance, resist bloodborne pathogens, and allow enough dexterity for fine manipulations required to perform medical tasks.

Protective gloves are designed to create a barrier against hazards. Using the correct hand protection can significantly reduce or eliminate potential injuries. Glove specification should be done after careful evaluation of potential hazards and glove protection characteristics. Select a glove that is appropriate. Consider factors associated with actual use that may affect the performance of the glove.

Because no single glove material will protect against all threats, it is important to match the glove to the type of threat. No glove material is totally impermeable. Glove performance can vary with product and manufacturer. The performance characteristics of a particular glove and its ability to protect against specific hazards are based on a number of factors including the glove material, its design, its construction, and its thickness and size.

Appropriate glove protection must not only protect against the specific threat likely to be encountered, it should provide a comfortable and secure fit that does not interfere with the ability to carry out normal duties. Gloves must first meet the basic criteria of providing good manual dexterity.

The gloves themselves must not aggravate existing allergies or promote medical complications such as latex allergy reactions. According to the National Institute for Occupational Safety and Health (NIOSH), a program of the Centers for Disease Control and Prevention, the increased use of latex gloves in and out of the workplace has resulted in an increase in reported irritant and allergic reactions to this material. According to the Occupational Safety and Health Administration (OSHA), the Food and Drug Administration (FDA) has received more than 1,000 reports of allergic reactions resulting from the use of latex gloves. Reactions are either due to exposure to the natural latex proteins or to chemicals added during the manufacturing process. As stated in NIOSH Publication 97–135, *Preventing Allergic Reactions to Natural Rubber Latex in the Workplace* (June 1997), studies indicate that 1 to 6 percent of the general population and 8 to 12 percent of regularly exposed health care workers are sensitized to latex. Allergic reactions to latex proteins can be a serious health risk with symptoms ranging from local skin irritation to more serious effects such as asthma, and, very rarely, anaphylactic shock. For more information on latex glove allergies and prevention measures, please refer to the following websites:

NIOSH: http://www.cdc.gov/niosh/latexalt.html
http://www.cdc.gov/niosh/98-113.html

OSHA: http://www.osha-slc.gov/SLTC/latexallergy/index.html

FDA: http://www.fda.gov/medbull/natural.html
http://www.fda.gov/cdrh/glvpwd.html

Protective gloves are a supplementary form of protection and should not be used as a substitute for good work practices. Understand the limitations of protective gloves and exercise proper care and maintenance. It is risky to wear gloves that have not been tested for viral penetration resistance when there is a chance of contact with blood or other bodily fluids, or materials containing biological hazards. It is also important to periodically replace unused supplies of latex gloves, as studies have demonstrated that age degradation increases the probability that these gloves may fail, as the tensile strength and elongation properties of these types of gloves decrease from aging. (See *Environmental Degradation of Latex Gloves, The Effects of Elevated Temperatures on Tensile Strength,* DMMS Report #96–05, by D.L. Walsh, D.J. Chwirut, R Kotz, and J. Dawson, published by the Food and Drug Administration, Rockville, Maryland.) Gloves made from synthetics, such as nitrile, do not experience the same degradation over time as latex gloves.

Inspection and care of protective gloves should be conducted routinely. Follow the manufacturer's instructions for the care and maintenance of protective gloves. Generally, reusable gloves should be thoroughly washed and rinsed according to the manufacturer's care instructions and allowed to air dry. Gloves should be replaced on a regular and frequent basis. Disposable gloves should be replaced frequently and never reused.

Developing the Test Protocol

As part of the development of the test protocol, NLECTC reviewed the major requirements for protective gloves and prepared a survey for the law enforcement and corrections community to help validate and prioritize the requirements (see sidebar). Based on survey results, protection from pathogens, cut resistance, puncture resistance, tactility, dexterity, and affordability emerged as the primary criteria for the evaluation and comparison of protective gloves. The leading companies in the protective garment materials industry were also consulted to determine the state of the art in protective glove technology.

At the same time, OLES reviewed existing industry standards and test methods that could be adopted for testing protective gloves and that would be applicable to the needs of the criminal justice community. OLES assembled various standards, procedures, and test methods from the following sources for the protective glove protocol: The Code of Federal Regulations, the American National Standards Institute/American Society for Quality Control, the National Fire Protection Association, the American Society for Testing and Materials, and British/European Standards.

Initially, OLES planned to develop an official NIJ protective glove standard from this compendium of standards, but the standard development team was concerned that the existing standards for cut and puncture resistance would not represent the real-world threat facing law enforcement and corrections in a meaningful manner. The team determined that it would be better to provide a set of standard test protocols that would enable the user community to compare the performance of protective gloves based on the test data provided. *NIJ Test Protocol 99–114, Test Protocol for*

Law Enforcement and Corrections Requirements for Protective Glove Survey

NLECTC developed a survey to rank law enforcement and corrections communities' top requirements and priorities for protective gloves. Survey respondents were asked to rate 15 criteria in order of importance.

The criteria included protective qualities, use qualities, and other practical considerations in choosing protective gloves. Protective criteria considered were pathogenic protection, chemical protection, electrical insulation, tear resistance, cut resistance, and puncture resistance. Use criteria included dexterity or ease in hand and finger manipulation; tactility or the quality of touch and feel when using a handgun or writing; holding capacity or ease in grasping objects; and human factors such as comfort, insulation, and moisture vapor transmission. Other criteria considered were inservice care, durability, test costs, unit costs, and availability.

The survey also asked respondents to comment on the practicality of carrying more than one set of gloves, such as disposable gloves for pathogen protection and a reusable set for cut and/or puncture resistance, given that the development of protective gloves that protect against all possible threats may not be practical or cost effective.

The priority, according to 70 percent of the survey responses, was pathogenic protection, followed by puncture resistance, dexterity, tear resistance, cut resistance, tactility, and holding capability. The survey respondents came from law enforcement, corrections, forensics, and other agencies. Responses were fairly evenly distributed from those who worked in agencies that were small, under 25; intermediate, 25 to 100; and medium, 101 to 500, with 11 percent of responses coming from large agencies of 501 or more. The responses came predominantly from supervisors, followed by line staff, administrators, support staff, and various other positions.

Comparative Evaluation of Protective Gloves for Law Enforcement and Corrections Applications, published in June 1999, is the first step in an ongoing process by NIJ, OLES, and NLECTC to evaluate the state of the art in protective glove technology. This bulletin summarizes the results of the initial round of tests. As more tests are performed and more data collected, the test protocol will be further refined and become the basis for an NIJ standard.

Participating Glove Manufacturers

AdTex, AS
(formerly known as International Security Protection, AS)
Schwensens Gate 5
0170 Oslo, NORWAY
Phone: (+47) 90 61 24 14
Fax: (+47) 90 42 26 42

Dakota Corporation
(Damascus Gloves/Slashguard/
Dave Larken)
P.O. Box 543
Rutland, VT 05702–0543
Phone: 800–451–4167
Fax: 877–326–2728
http://www.damgloves.com

Gimbel Glove Company, LLC
7720 North 16th Street
Suite 370
Phoenix, AZ 85020
Phone: 888–667–8425
Fax: 602–944–7934
http://www.gimbelglove.com

HIGH FIVE Products, Inc.
319 W. Ontario
Chicago, IL 60610
Phone: 888–253–9292
Fax: 312–266–9171
http://www.highfivegloves.com

Microflex
P.O. Box 32000
Reno, NV 89533–2000
Phone: 800–876–6866
775–746–6600
Fax: 775–746–6577
http://www.microflex.com

Safeskin Corporation
(Kimberly Clark Scientific & Industrial)
12777 High Bluff Drive
San Diego, CA 92130
Phone: 800–462–9993
http://www.safeskin.com

Samco Co.
122 South Main Street
Gloversville, NY 12078
Phone: 518–725–4705

Speith & Weinsky
(Distributed by Masley Enterprises, Inc.)
222 Waverly Road
Wilmington, DE 19803
Phone/Fax: 302–427–9885

Warwick Mills (Turtleskin Gloves)
P.O. Box 409
301 Turnpike Road
New Ipswich, NJ 03071
Phone: 888–477–4675
http://www.turtleskin.com

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The National Institute of Justice is a component of the Office of Justice Programs, which also includes the Bureau of Justice Assistance, Bureau of Justice Statistics, Office of Juvenile Justice and Delinquency Prevention, and Office for Victims of Crime.

New Publications/Videos

The following publications/videos are available from the National Law Enforcement and Corrections Technology Center–National:

Selection and Application Guide to Personal Body Armor, NIJ Guide 100–01. This guide responds to questions about the selection and use of body armor for law enforcement. It responds to commonly expressed concerns and provides information to help determine the level of protection required by officers. This guide provides information on the newly released 0101.04 ballistic-resistant standard and the new stab-resistant standard (NIJ Standard-0115.00).

Surviving a Shooting: Your Guide to Personal Body Armor. This 19-minute videotape provides a synopsis of the National Institute of Justice (NIJ) publication titled *Selection and Application Guide to Personal Body Armor.* Covered in the videotape are what body armor is, what it can and cannot protect against, how to select it, and how to wear and care for it.

National Law Enforcement and Corrections Technology Center Publications Catalog 2002. This document provides a listing of NLECTC and other government publications of interest to law enforcement, corrections, and forensic sciences practitioners. Categories include communications, forensics, less-than-lethal weapons, protective equipment, and weapons and ammunition.

Michigan State Police Tests 2002 Police Vehicles. This bulletin summarizes test results from the Michigan State Police's annual evaluation of police-package and special-service patrol vehicles.

A Comprehensive Evaluation of 2001 Patrol Vehicle Tires. This bulletin summarizes results of NIJ's latest comprehensive evaluation of patrol vehicle tires.

A Guide for Applying Information Technology in Law Enforcement. This publication seeks to help law enforcement professionals choose the information technologies that best suit their needs and incorporate them into their day-to-day operations. This guide is intended to help law enforcement practitioners plan and implement information system upgrades and address connectivity and data sharing issues.

2001 Mock Prison Riot Videotape. This video features technologies used to quell a mock prison riot staged by NIJ's Office of Law Enforcement Technology Commercialization. Emerging technologies were incorporated into training scenarios to demonstrate the latest technologies.

To obtain any of the above publications or videotapes, write NLECTC, P.O. Box 1160, Rockville, MD 20849–1160; telephone 800–248–2742. Publications can also be downloaded from JUSTNET at www.justnet.org.

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