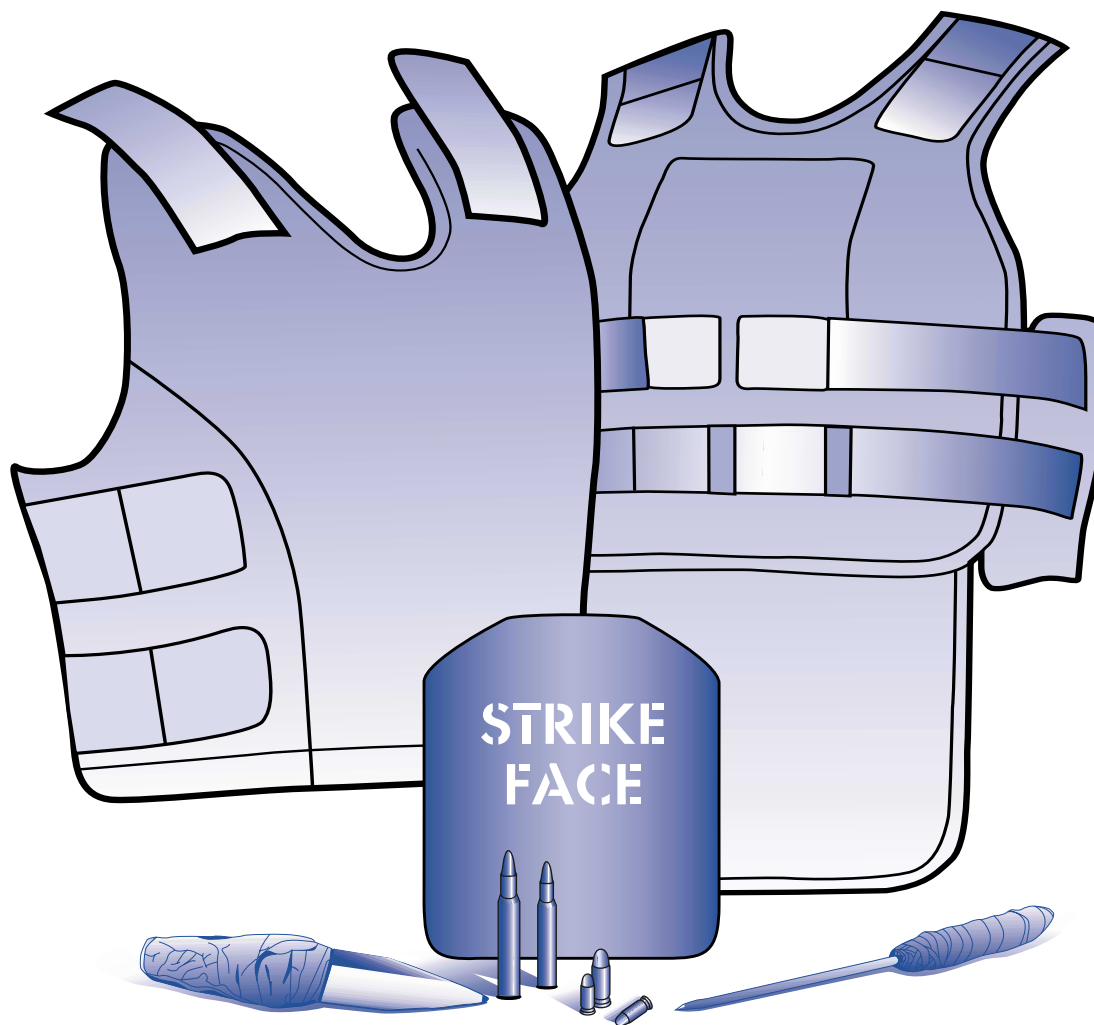




Selection and Application Guide to Personal Body Armor

NIJ Guide 100-01 (Update to NIJ Guide 100-98)



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Selection and Application Guide to Personal Body Armor

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Foreword

NIJ is pleased to release this updated edition of NIJ's guide to selecting body armor. The update incorporates several important changes:

First, it includes information from the new *Ballistic Resistance of Personal Body Armor, NIJ Standard-0101.04*, which was the result of 3 years of study, research, and collaboration by the Office of Law Enforcement Standards (OLES) at the National Institute of Standards and Technology. It also contains information on NIJ's new *Stab Resistance of Personal Body Armor, NIJ Standard-0115.00*, which was developed by OLES in conjunction with the Police Scientific Development Branch of the United Kingdom and released in September 2000.

Second, the title has changed from the *Selection and Application Guide to Police Body Armor to the Selection and Application Guide to Personal Body Armor*. The title change reflects recognition of the need for corrections officers to wear body armor just as law enforcement officers do.

We at NIJ, the National Law Enforcement and Corrections Technology Center (NLECTC) system, and OLES are excited about the forward progress and momentum that these new standards will produce in body armor technology.

We hope criminal justice agencies will use this guide as they select protective armor that is suited to their individual needs.

Your comments on the usefulness of this document or suggestions for future editions are welcome. Please send them to NLECTC, c/o *Selection and Application Guide to Personal Body Armor*, P.O. Box 1160, Rockville, MD 20849-1160; fax to 301-519-5149; or e-mail to asknlectc@nlectc.org.

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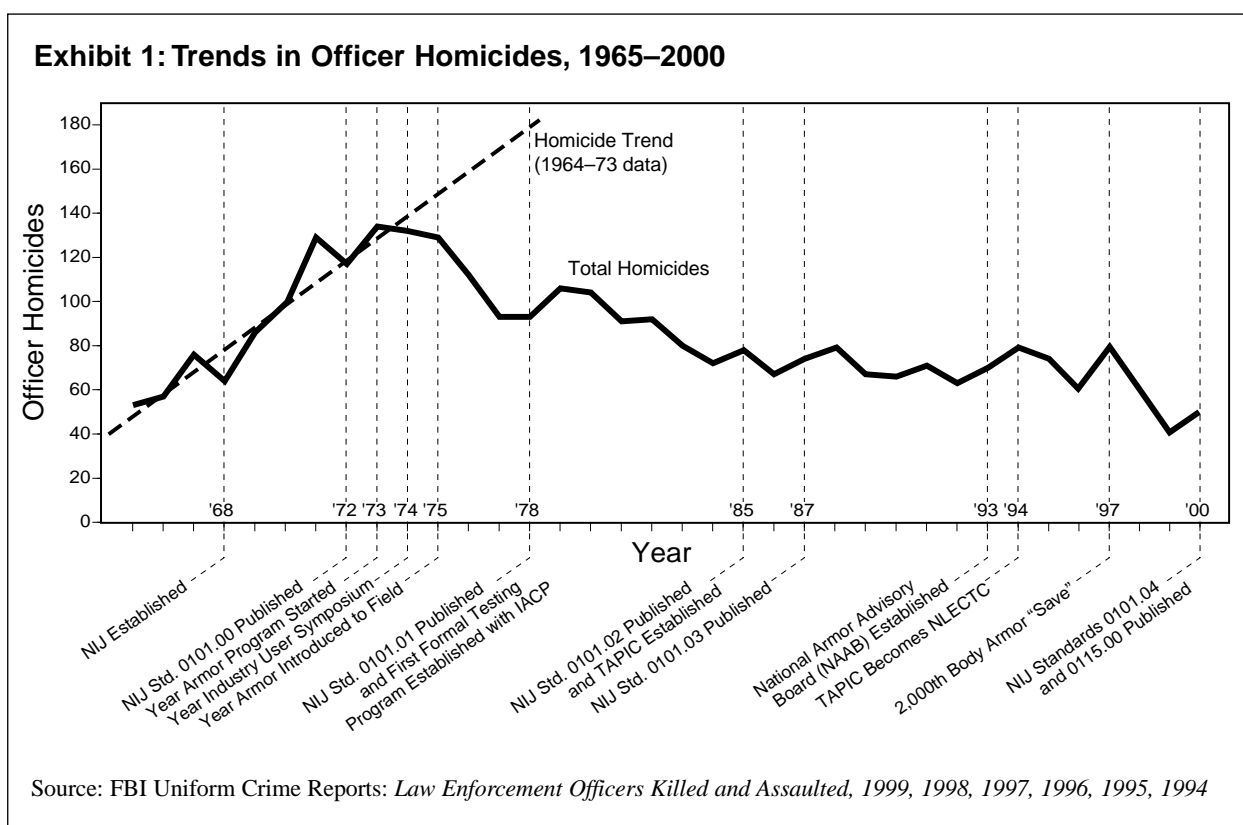
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1. Overview of the Guide

Lightweight body armor has been widely available for use by law enforcement personnel for more than 25 years. The dramatic reduction in officer homicides following the introduction of body armor, as shown in exhibit 1, attests to the protection it provides. This success story extends far beyond protection from handguns—an estimated 2,500¹ lives have been spared, including cases in which body armor prevented serious injuries to officers from other types of assaults or accidents.



The National Institute of Justice² (NIJ) has developed standards for body armor performance through its Office of Law Enforcement Standards (OLES). The standard for ballistic resistance of body armor was developed 28 years ago and has gone through four revisions. In September 2000, NIJ introduced its standard for stab and puncture resistance of body armor.

Body armor is tested as a part of the National Law Enforcement and Corrections Technology Center (NLECTC) voluntary equipment testing program to determine compliance with the NIJ standards, and NLECTC disseminates those test results and other pertinent information to the law enforcement and corrections communities. A consumer product list of armor models that

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comply with the requirements of the standards is available from NLECTC through its Web site, JUSTNET, at <http://www.justnet.org>.³

While body armor is a household word in the criminal justice community, questions about its selection and use are frequently asked. This guide responds to commonly expressed concerns. It provides information to help determine what level of protection is consistent with the threats to which individual officers are exposed. It also discusses armor selection from the variety of styles available, together with the proper care of armor in service. The NIJ standards are discussed in detail, as well as the use of the standards in armor procurement. In addition, the guide discusses administrative concerns, including the issue of replacing inservice armor, and describes other sources of information.

NIJ asks all departments to exercise prudent judgment in selecting armor appropriate to their needs. In so doing, NIJ urges proper attention to those factors that affect the wearability of armor in order to encourage routine, full-time use by all on-duty officers. The temptation to order armor that provides more protection than realistically needed should be resisted, because doing so may increase the likelihood that the armor will not be worn routinely.

This guide opens with a history of the development of body armor and background on the lives it has saved. The heart of the guide—how to proceed to select and purchase body armor—begins with chapter 6 and includes chapters explaining how to assess the level of protection needed, things to think about when selecting armor, and ways to keep it in proper working order. An extensive collection of appendixes is available for reference.

2. A History of Body Armor

Humans throughout recorded history have used various types of materials to protect themselves from injury in combat and other dangerous situations. At first, protective clothing and shields were made from animal skins. As civilizations became more advanced, wooden shields and then metal shields came into use. Eventually, metal also was used as “clothing,” what we now refer to as the suit of armor associated with the knights of the Middle Ages. However, with the advent of firearms (c.1500), most of the traditional protective devices were no longer effective. In fact, the only real protection available against firearms were manmade barriers, such as stone or masonry walls; manmade fortifications such as trenches and ditches; or natural barriers, such as rocks and trees.

One of the first recorded instances of soft armor use was by the medieval Japanese, who used armor manufactured from silk. Although the first U.S. law enforcement officer to lose his life in the line of duty, New York City Deputy Sheriff Isaac Smith, was shot and killed in 1792,⁴ it was not until the late 19th century that the first use of soft armor in the United States was recorded. At that time, the military explored the possibility of using soft armor manufactured from silk. The project even attracted congressional attention after the assassination of President William McKinley in 1901. But while the garments were shown to be effective against low-velocity bullets (traveling at 400 feet per second (ft/s) or less), they did not offer protection against the new generation of handgun ammunition being introduced at that time that traveled at velocities of more than 600 feet per second. This, along with the prohibitive cost of manufacturing the garment (\$80 each, which is equal to approximately \$1,500 in today’s dollars) made the concept unacceptable. Armor of this type was said to have been worn by Archduke Francis Ferdinand of Austria when he was killed by a shot to the head, thereby precipitating World War I.⁵

The U.S. Patent and Trademark Office lists records dating back to 1919 for various designs of bullet-resistant garments. One of the first documented instances where such a vest was demonstrated for use by law enforcement officers is detailed in the April 2, 1931, edition of the Washington, D.C., *Evening Star* (see photo, right), which reported on a vest demonstration for members of the Metropolitan Police Department. However, none of these designs proved entirely effective or feasible for law enforcement or corrections use.

Photo unavailable online

The next generation of ballistic vests was introduced during World War II. The “flak

jacket,” constructed of ballistic nylon, provided protection primarily from munitions fragments and was ineffective against most pistol and rifle threats. These vests also were very cumbersome and bulky and were restricted primarily to military use. It would not be until the late 1960s that new fibers would be discovered that would make today’s generation of concealable body armor possible.

The History of NIJ’s Body Armor Testing Program

During the 1960s this country witnessed a dramatic rise in officer fatalities. From 1966 to 1971, the number of law enforcement officers killed each year in the line of duty more than doubled, from 57 to 129 (see exhibit 1, page 1). Concerned by this rapid increase in officer fatalities and recognizing that a majority of the homicides were inflicted with handguns, the National Institute of Law Enforcement and Criminal Justice (NILECJ)—predecessor of the National Institute of Justice (NIJ)—initiated a research program to investigate the development of a lightweight body armor that on-duty police could wear full time.

The investigation readily identified new materials that could be woven into a lightweight fabric with excellent ballistic-resistant properties. Following initial laboratory research, the agency concluded that the objective of producing body armor suitable for full-time police use was achievable. In a parallel effort, the National Bureau of Standards’ (now known as the National Institute of Standards and Technology) Law Enforcement Standards Laboratory (now known as the Office of Law Enforcement Standards (OLESS)) developed a performance standard⁶ that defined ballistic-resistant requirements for police body armor. The National Bureau of Standards was a part of the NIJ Technology Assessment Program, which today is known as the National Law Enforcement and Corrections Technology Center (NLECTC).

Of all the equipment developed and evaluated in the 1970s by NIJ, one of its most significant achievements was the development of body armor that employed DuPont’s Kevlar® ballistic fabric, which was originally developed to replace steel belting in vehicle tires. Lester Shubin, who served as NIJ Technology Assessment Program Manager from 1971 to 1991, suspected the new substance might have potential to greatly improve personal armor. He and Nicholas Montanarelli, then an Army Land Warfare technology specialist, took a piece of Kevlar® to a gun range, folded it over a couple of times, and shot at it. The bullets did not go through.

During the following 5 years, from 1971 to 1976, more than \$3 million of NIJ funds were devoted to the development of body armor. The research and development program was a team effort involving several of the most innovative and technologically advanced private and government organizations in the country. Contractors from the private sector were The Aerospace Corporation and MITRE Corporation. The U.S. Army’s contribution included the efforts of Edgewood Arsenal, Aberdeen Proving Grounds, and Natick Laboratories. The Lawrence Livermore Laboratory and the National Bureau of Standards were also involved in the program, as were the Federal Bureau of Investigation (FBI) and the U.S. Secret Service.

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The development of body armor by NIJ was a four-phase effort that took place over several years. The first phase involved testing Kevlar® fabric to determine whether it could stop a lead bullet. The second phase involved determining the number of layers of material necessary to prevent penetration by bullets of varying speeds and calibers and developing a prototype vest that would protect officers against the most common threats—the .38 Special and the .22 Long Rifle bullets. Bullets from 9mm, .45, and .32 caliber weapons also were investigated.

By 1973, researchers at the Army's Edgewood Arsenal responsible for vest design had developed a garment made of seven layers of Kevlar® fabric for use in field trials. During this preliminary testing, environmental trials determined that the penetration resistance of Kevlar® was degraded when wet. The bullet-resistant properties of the fabric also diminished upon exposure to ultraviolet light, including sunlight. Drycleaning agents and bleach also had a negative effect on the antiballistic properties of the fabric, as did repeated washing. To protect against these problems, the vest was designed with waterproofing, as well as with fabric coverings to prevent exposure to sunlight and other degrading agents.

The third phase of the initiative involved extensive medical testing to determine the performance level of body armor that would be necessary to save police officers' lives. It was clear to researchers that even when a bullet was stopped by the flexible fabric, the impact and resulting trauma from the bullet would leave a severe bruise at a minimum and, at worst, could kill by damaging critical organs. Subsequently, Army scientists designed tests to determine the effects of blunt trauma—the injuries suffered from forces created by the bullet impacting the armor. A byproduct of the research on blunt trauma was the improvement of tests that measure blood gases, which indicate the extent of injuries to the lungs.

The final phase involved monitoring the armor's wearability and effectiveness. An initial test in three cities determined that the vest was wearable, it did not cause undue stress or pressure on the torso, and it did not prevent the normal body movement necessary for police work. In 1975, an extensive field test of the new Kevlar® body armor was conducted, with 15 urban police departments cooperating. Each department served a population larger than 250,000, and each had experienced officer assault rates higher than the national average. The tests involved 5,000 garments, including 800 purchased from commercial sources. Among the factors evaluated were comfort when worn for a full working day, its adaptability in extreme temperatures, and its durability through long periods of use.

Equally important in this test was the psychological effect of the garments on the officers—whether wearing them would enable them to be more confident or relaxed in their encounters with the public or inspire them to take more chances with their lives or the lives of others. The tests showed that the armor could be worn without restricting officers' ability to do their jobs and, more importantly, that the vests worked.

The first instance of a vest saving a participating officer's life occurred less than 6 months after it was issued to him. During the 1-year demonstration period, 18 shooting incidents occurred in which body armor successfully protected the officers. The demonstration project armor issued

by NIJ was designed to ensure a 95-percent probability of survival after being hit with a .38 caliber bullet at a velocity of 800 ft/s. Furthermore, the probability of requiring surgery if hit by a projectile was to be 10 percent or less.

The Use of Body Armor Today

A final report released in 1976 concluded that the new ballistic material was effective in providing a bullet-resistant garment that was light and wearable for full-time use. Private industry was quick to recognize the potential market for the new generation of body armor, and body armor became commercially available in quantity even before the NIJ demonstration program.

For the past 25 years, the routine use of body armor by law enforcement officers occurred primarily in the United States because assault by firearms on law enforcement officers in other countries was not as common. However, with the proliferation of international terrorism and related firearms attacks against officers, the use of body armor in other countries is becoming increasingly commonplace.

NLECTC has seen a dramatic increase in the number of submissions of new body armor models from manufacturers around the world. The NIJ standard for ballistic-resistant body armor has gained worldwide acceptance as a benchmark to judge the effectiveness of a given body armor model. In response, NIJ is reaching out to the international community in a cooperative effort for the development of future revisions of the standard.

While the most common type of threat faced by a police officers is from a gun, the most common threat a correctional officer is likely to face is from a knife or ice pick. In response to the needs of the corrections community, NIJ has developed a performance standard for stab- and puncture-resistant body armor, through a collaboration of OLES, the U.S. Secret Service, and the Police Scientific Development Branch (PSDB) in the United Kingdom (UK). In September 2000, NIJ introduced a performance standard for stab- and puncture-resistant body armor, *Stab Resistance of Personal Body Armor, NIJ Standard-0115.00*.

Today, more than 80 manufacturers produce body armor and participate in NIJ's voluntary compliance testing program. Other types of bullet-resistant armor, which were much heavier and bulkier than vests made with the new technology, have virtually disappeared from the market. Estimates indicate that the body armor industry conducts \$200 million in business in the United States annually, the majority of which is for use related to law enforcement and the military.⁷

NIJ's body armor program was instrumental in developing a garment that is not only wearable, but that has contributed significantly to the safety of our Nation's law enforcement officers. Every facet of the development phase was aimed at protecting the life of the law officer on the street. This remains the program's purpose today.

3. Why Wear Body Armor?

The Cost

Since the death of New York City Deputy Sheriff Isaac Smith in 1792, more than 15,000 officers have fallen in the line of duty—many of these men and women killed by firearms.⁸

The use of weapons of all types, particularly handguns, by those with criminal intent, poses a constant threat to police officers, whether they are responding to a domestic quarrel or to an armed robbery. All too frequently, a domestic disturbance erupts into violence when family members redirect their anger toward the officer attempting to effect a peaceful resolution. Similarly, a routine traffic stop can result in an unexpected armed confrontation. At times like these, an officer needs the protection provided by body armor.

Logic dictates the routine use of body armor. Still there are those who do not wear it regularly, often in spite of departmental regulations to do so. Those who do not wear armor usually claim that the bulk and weight of armor make it uncomfortable. But case studies and statistics support the importance of the routine use of body armor. As part of the Uniform Crime Reports, the Federal Bureau of Investigation (FBI) publishes its annual report *Law Enforcement Officers Killed and Assaulted* (LEOKA), which contains detailed analysis of the situations and circumstances surrounding assaults on law enforcement officers—a “must read” for all law enforcement personnel.

The 1994 edition of the LEOKA report contains a summary of an FBI study that demonstrates that the risk of sustaining a fatal injury for officers who do not routinely wear body armor is **14 times** greater than for officers who do. (A copy of the report summary is included in appendix C of this guide.)

The National Institute of Justice (NIJ) believes that it is in the best interest of all police departments to promote the full-time use of body armor. Aside from armor sparing officers and their families pain and suffering, the economic impact on a department when an officer is killed in the line of duty is staggering.

The following statistics illustrate the importance of wearing body armor to the entire law enforcement community and beyond. Since 1973 and as of January 1, 2001, a total of 2,500 “saves” have been attributed to the use of body armor. Fifty-eight percent of these saves were connected with felonious assaults and 42 percent with accidents, such as car crashes. Forty percent of the felonious assaults involved firearms, 12 percent represented cutting or slashing assaults, and 6 percent involved other types of assaults. According to the International Association of Chiefs of Police (IACP)/DuPont Kevlar Survivors’ Club®, the estimated cost of an officer’s death is \$1.3 million. This figure is based on funeral expenses, death and pension benefits, and the cost to a department to hire and train a replacement officer.

In 1976, the Public Safety Officers' Benefits (PSOB) Act (42 U.S.C. 3796, et. seq.) was enacted into law by Congress to assist the families of State and local law enforcement officers and firefighters killed or permanently disabled in the line of duty. The families of these officers slain on or after September 29, 1976, were eligible to receive a \$50,000 death benefit payment. In 1984, families of Federal law enforcement officers and firefighters killed or disabled in the line of duty were also made eligible. The benefit was increased to \$100,000 in 1988, with a provision that this amount would be adjusted each October 1 to reflect the percentage of increase in the Consumer Price Index. For fiscal year (FY) 1999, the amount was \$143,943. Since 1977, the Bureau of Justice Assistance (BJA), which administers this program, has received an average of 275 claims each year. In FY99, the PSOB program paid out a total of \$29,837,908 in death and disability benefits to qualifying survivors under this program, and in FY00, a total of \$28,292,684 in death and disability benefits.⁹

In addition to the Federal PSOB program, many States also have benefits available to the survivors; however, each State varies as to the benefits they provide. Among the various benefits available are a one-time death benefit, a pension payment, waiver of property taxes, tuition-free education, and continuation of health care coverage for surviving children and/or spouses.

Concerns of Police Survivors (COPS), an organization dedicated to assisting and providing resources to the families of slain officers, has compiled information on benefits available to law enforcement survivors in all 50 States, the District of Columbia, and Puerto Rico. Information is updated on an ongoing basis. This information includes benefits sources and contact information. Information on how to contact COPS is included in the resource list (appendix A) at the end of this publication.

The Ballistic Threat

The current generation of body armor was developed specifically to protect against injury from assault with handguns. A review of the statistics concerning weapons confiscated nationwide during the period from 1964 to 1974 identified the .38 caliber handgun, firing bullets at a velocity of 800 ft/s, as the most common weapon threat to officers. In fact, .38 caliber and smaller handguns accounted for more than 85 percent of the confiscated weapons. Since the introduction of body armor in the mid-1970s, a review of the *Law Enforcement Officers Killed and Assaulted* report continues to support the fact that the most common threat faced by law enforcement officers is handgun assaults. However, trends indicate that the 9mm semiautomatic pistol has surpassed the .38 caliber handgun as the most common threat (see exhibit 2).

When an individual is hit by a bullet, the extent of the injury sustained depends on where the bullet strikes the body and the path or trajectory of the bullet into or through the body. Injury to the vital organs is most often fatal. Thus, the armor's primary and most obvious purpose is to prevent a bullet from penetrating the torso.

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Exhibit 2: Officers Feloniously Killed by Handguns

Type and Size of Handgun As Reported (1985–1999)

Caliber of Handgun	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987	1986	1985	Caliber Totals
.22 Caliber	1	4	3	4	1	5	3	1	3	2	3	2		5	3	41
.22 Magnum	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
.25 Caliber	1	3	2	3	3	2	1	2	3	0	2	2	2	0	4	30
.32 Caliber	0	1	4	1	1	0	0	0	3	2	0	1	4	1	4	22
.357 Magnum	2	3	3	4	3	1	5	9	12	10	7	15	13	14	15	116
.38 Caliber	4	6	10	5	6	11	11	13	10	18	19	23	18	20	17	191
.380 Caliber	0	1	3	6	6	6	9	2	1	0	1	2	2	0	3	42
9 Millimeter	12	14	9	10	12	26	11	8	12	8	4	6	4	4	3	143
9 x 18 Millimeter	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
10 Millimeter	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
.40 Caliber	2	1	4	2	3	2	3	0	0	0	0	0	0	0	0	17
.41 Magnum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
.44 Magnum	0	1	0	1	3	2	0	1	0	1	0	6	3	1	1	20
.45 Caliber	1	5	4	3	4	2	3	2	4	2	2	4	0	5	3	44
.455 Caliber	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Caliber Not Reported	1	1	2	4	1	5	4	4	2	4	2	1	1	1	4	37
Yearly Total	25	40	44	44	43	63	50	42	50	48	40	62	48	51	58	708

Source: FBI Uniform Crime Reports: *Law Enforcement Officers Killed and Assaulted 1999, 1998, 1997, 1996, 1995, 1994*

In the case of hard armor, such as metal, rigid reinforced plastic, or ceramic materials, it is possible to use armor of such a thickness that it does not appreciably deform from the bullet impact. If, however, the armor that covers the torso deforms from the bullet impact, the surface of the armor against the body at the point of impact will be forced against or into the skin. Unlike a penetrating wound, in which the skin is broken and the bullet tears through the body, the deformation of armor from bullet impact results in blunt trauma. This type of nonpenetrating injury can cause severe contusions (bruises) or internal damage and can even result in death. As a result, this NIJ standard also evaluates the capabilities of the armor to prevent injury from blunt trauma.

Simply speaking, the design of ballistic-resistant armor requires identifying the threat, selecting a material or combination of materials that will resist that threat, and determining the number of layers of material necessary to prevent both penetration and blunt trauma injury. The armor's final weight is an important design factor in the selection of the ballistic-resistant material or materials to be used. The goal is to design the lightest possible unit that achieves the desired protection while still providing comfort and not restricting movement.

The degree of threat to armor from handguns depends on many factors: caliber, bullet configuration and composition (e.g., lead roundnose, jacketed hollow-point, full metal jacketed, armor piercing), weight, and impact velocity. Thus, armor that defeats a specific projectile at one impact velocity may not defeat the same caliber projectile at a higher velocity or of a different composition or configuration.

On the whole, a continuous range of threat levels undoubtedly exists for the different weapon and ammunition combinations available. As with clothing, which allows selection from a limited range of garment type and weight depending on climate and season, it has proven satisfactory to establish six armor types (protection level classifications) that enable the selection of armor to protect against most common threats, including sporting and armor-piercing rifle bullets.

All departments should periodically review the information used to select the level of protection (armor type classification) when the armor was purchased. Evaluate changes in service weapons or ammunition with respect to the type of armor used by officers. Equally important are changes in the weapons or ammunition of the local criminal population. If changes have occurred and increased the threat to officers, the department should consider upgrading its armor.

It should be noted that concealable ballistic-resistant body armor is potentially vulnerable to knife attack; hence, all officers should exercise due caution when confronted with these situations. However, numerous incidents have been documented in which body armor lessened injury. Several manufacturers currently market vests claiming to offer protection against knife attacks, although most of these vests carry warnings indicating that they do not provide protection against *all* sharp-edged and pointed threats, just as a ballistic-resistant vest cannot be totally bulletproof.

The details of armor classification and selection are discussed in chapters 6, 7, and 8. For the moment, it is sufficient to recognize the importance of being realistic in assessing the threat to officers. The weight and bulk of body armor can increase significantly as greater threat protection is demanded; both of these factors can discourage full-time use of body armor.

The Stab Threat

The most common threat a correctional officer is likely to face is from a knife or ice pick. In response to the needs of the corrections community, NIJ has developed a performance standard for stab- and puncture-resistant body armor, through a collaboration of the Office of Law Enforcement Standards (OLEs), the U.S. Secret Service, and the Police Scientific Development Branch (PSDB) in the United Kingdom (UK). *Stab Resistance of Personal Body Armor, NIJ Standard–0115.00*, was released in September 2000.

NIJ Standard–0115.00 places stab-resistant body armor into two categories, based on the kind of threat it is designed to stop. One category of protection, designated the “edged blade” class, stops engineered or high-quality blades, such as kitchen knives or those purchased at sporting goods stores, and represents the threat more commonly found on the street. The second category, the “spike” class, stops the types of improvised weapons commonly found in correctional facilities, typically of lower quality materials that may have been sharpened on concrete or other rough surfaces.

Not Just Bullets and Knives

The original NIJ body armor effort focused solely on the urgent need to protect law enforcement personnel from handgun assault. As with most new technology, body armor has proven useful in ways not thought of when first put into service. The same properties that provide ballistic protection—resistance to penetration and blunt trauma—when combined with abrasion resistance have also saved many officers from serious physical injury in vehicular accidents.

In one incident, during the course of a routine patrol, an officer was negotiating a sweeping right-hand curve at a high rate of speed when his car ran off the edge of the pavement. As he brought it back onto the pavement, he lost control. After fishtailing several times, the car became airborne and crashed head on into a rocky hillside. The officer suffered a fractured sternum, sprained right thumb, possible concussion, and pain in the neck area. There is every reason to believe that the body armor the officer was wearing saved the officer’s life.

Although the development of air bags and other safety-related technologies in vehicles has lessened the severity of injuries, medical experts have concluded that body armor mitigates injury in head-on collisions when the driver is thrown against the steering wheel, particularly when the seat belt is fastened.

Officers assigned to motorcycle duty are especially vulnerable to injury in vehicular accidents. A member of the California Highway Patrol was traveling at approximately 45 mph when he heard the sound of a vehicle approaching rapidly from the rear. He was attempting to move to the right when he was struck by the vehicle in the left rear. The motorcycle spun counterclockwise. He was thrown from the motorcycle, landing on his back and sliding on the pavement for approximately 100 feet before coming to a rest. He sustained only minor injuries to his right elbow and right leg. This convincing example demonstrates the nonballistic protection that body

armor can offer. In addition, body armor also has protected numerous officers from injury from physical assault with 2 by 4's, baseball bats, and other rigid objects.

2,500 Reasons

The first recorded incident of a U.S. law enforcement officer's life being saved as a result of wearing a concealable ballistic vest occurred May 17, 1973, in Detroit, Michigan. Police Officer Ron Jagielski, along with several other officers, was working on a plainclothes assignment involving narcotics trafficking. Ready to enter the residence under surveillance and make the bust, Jagielski was hit in the chest when a bullet pierced the building's front door. A .38 caliber special bullet was later found embedded in his ballistic vest, just below the area of his heart. Had it not been for the protection afforded by the body armor, Jagielski would surely have suffered a fatal injury.

Nearly a quarter-century later, on January 3, 1997, Deputy Henry Huff became the 2,000th law enforcement official to be placed on the IACP/DuPont list of those saved by concealable body armor. A member of the Walton County, Georgia, Sheriff's Office, Huff was shot at point blank range during a traffic stop by a 16-year-old male armed with a 9mm weapon. The surveillance camera in Huff's squad car caught the entire incident on videotape. Despite being shot twice in the chest, Huff was spared from serious injury.

The IACP/DuPont Kevlar Survivors' Club® commemorated the 2,500th body armor save in November 2000 by recognizing five officers selected from five different branches of law enforcement. One of the saves was Officer Jeffrey Seaman of the Philadelphia (Pennsylvania) Police Department, who found himself the subject of cartoonist Rob Armstrong's syndicated strip, "Jump Start." For 2 weeks, the strip featured Officer Seaman's story, depicting the actual shooting event, the reactions of his department and family, including his mother, a corporal in the same department, who had always encouraged her son to wear his body armor. The strip concluded during National Police Week in Washington, D.C., with Officer Seaman visiting the wall at the National Law Enforcement Officers' Memorial, and, in the final strip, being inducted in the Survivors' Club.

In 1987, a study by DuPont found that while most police officers recognized the dangers of their jobs and 65 percent of those surveyed owned body armor, only 15 to 20 percent actually used it. The reasons given for not wearing body armor ranged from legitimate concerns such as comfort and weight, to misconceptions about an officer's ability to survive blunt trauma caused by a bullet that has been stopped by a vest.

In that same year, the IACP Board of Officers authorized the formation of the IACP/DuPont Kevlar Survivors' Club®. The objectives of this club are to:

- Reduce death and disability by encouraging the increased wear of personal body armor through documentation of the armor's effectiveness.

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- Recognize individuals who, as a result of wearing personal body armor, have survived a life-threatening incident.
- Serve the law enforcement community by collecting these important data and sharing valuable information related to these survivor incidents.

By publishing the accounts of saves in *Police Chief* magazine and engaging in other supportive efforts, the Survivors' Club has helped educate law enforcement officers about the benefits of always wearing body armor. Many departments now routinely provide body armor and mandate its wear while officers are on duty. In some locations, concerned citizens have undertaken fundraising activities to purchase body armor for local law enforcement officers.

According to a 1997 Bureau of Justice Statistics (BJS) survey of 700 State and local law enforcement agencies with 100 or more officers,¹⁰ approximately 40 percent of sheriff's and municipal police departments, and 25 percent of State and county police departments, require all field officers to wear body armor, compared to almost 30 percent in the same survey conducted in 1993.¹¹

The 1993 BJS survey also reported that more than 80 percent of the 661 agencies surveyed for that year provided either body armor or cash allowances to purchase body armor to all of their uniformed patrol officers. In comparison, the same survey conducted by BJS in 1987 indicated that only 28 percent of agencies surveyed provided armor or a cash allowance to purchase armor.¹²

4. Body Armor Construction

How Does Ballistic-Resistant Body Armor Work?

When a handgun bullet strikes body armor, it is caught in a “web” of very strong fibers. These fibers absorb and disperse the impact energy that is transmitted to the vest from the bullet, causing the bullet to deform, or “mushroom.” Additional energy is absorbed by each successive layer of material in the vest, until such time as the bullet has been stopped.

Because the fibers work together both in the individual layer and with other layers of material in the vest, a large area of the garment becomes involved in preventing the bullet from penetrating. This also helps in dissipating the forces that can cause nonpenetrating injuries (what is commonly referred to as “blunt trauma”) to internal organs. Unfortunately, at this time no material exists that would allow a vest to be constructed from a single ply of material.

Today’s generation of concealable body armor can provide varying levels of protection to defeat most common low- and medium-energy handgun rounds. Body armor designed to defeat rifle fire is of either semirigid or rigid construction, typically incorporating hard materials such as ceramics and metals. Because of its weight and bulkiness, it is impractical for routine use by uniformed patrol officers and is reserved for use in tactical situations, where it is worn externally for short periods of time when confronted with higher level threats.

How Does Stab-Resistant Body Armor Work?

Stab-resistant body armor works by many of the same principles as ballistic-resistant body armor. Stab- and puncture-resistant armors are made from a variety of materials. The most common designs use multiple layers of materials. These layers are made from extremely strong fibers that can be either woven or laminated together. Other materials used are metals and composites. As the threat impacts the armor, the materials either deflect the threat, or due to their very high levels of tensile strength and cut and/or tear resistance, they slightly “stretch” before breaking or being cut. This “stretching” spreads the impact forces over a larger area of the armor and dissipates the strike energy from the threat, eventually stopping the threat. Most often, multiple layers of materials are needed to successfully stop typical threats. Some of the top layers of material may be defeated, but if properly designed, the armor will stop the threat with little to no penetration. The backing layers provide additional strength to the armor, and each layer assists in dissipating the strike energy.

Many of the same materials are used in both ballistic-resistant armor and stab-resistant armor, with one important distinction. Because knives, picks, and spikes are pointed, the initial contact forces for stabs threats are very high. These high forces pose a risk to ballistic-resistant armor. To counter this, stab-resistant armors are normally made from very tightly woven fabrics or from very closely spaced laminated layers.

Construction Methods

Typically, concealable body armor is constructed of multiple layers of ballistic- or stab-resistant materials, assembled into the “protective panel.” The protective panel is then inserted into the “carrier,” which is constructed of conventional garment fabrics such as nylon or cotton. The protective panel may be permanently sewn into the carrier or may be removable. Although the overall finished product looks relatively simple in construction, the protective panel is very complex.

Manmade fabrics are available from a number of manufacturers in various styles and compositions, each type having unique ballistic- or stab-resistant properties. The body armor manufacturer may construct a given model of ballistic- or stab-resistant panel from a single fabric style or from two or more styles in combination. The location and number of layers of each style within the multiple-layer protective panel influence the overall performance of the panel. In addition, some manufacturers coat the fabric with various materials. For example, the manufacturer may add a layer of nonballistic or stab-resistant material for the sole purpose of increasing blunt trauma protection. Even composites of two or more different ballistic materials are available. As a consequence, it is impossible to compare one product with another based solely on the number of fabric layers in the protective panel.

The manner in which the ballistic- or stab-resistant panels are assembled into a single unit also differs from one manufacturer to another. In some cases, the multiple layers are bias stitched around the entire edge of the panel; in others, the layers are tack stitched together at several locations. Some manufacturers assemble the fabrics with a number of rows of vertical or horizontal stitching; some may even quilt the entire panel. No evidence exists that stitching impairs the ballistic- or stab-resistant properties of a panel. Instead, stitching tends to improve the overall performance, especially in cases of blunt trauma, depending on the type of fabric used.

The differences between protective panels in various manufacturers’ products result from individual design concepts meant to achieve a given level of performance with minimum weight and maximum comfort or wearability. If armor has been demonstrated to provide the desired level of protection in accordance with the National Institute of Justice (NIJ) standards, the user should not be concerned with the design, but should look for proper fit and comfort.

Body armor intended for routine use is most often designed to be worn beneath the normal uniform shirt. Again, manufacturers tend to design different methods of attaching armor to the body. Hook-and-pile fasteners are common, as are “D” ring tightening straps. With the exception of metal fasteners of any type (which can deflect a bullet on impact and pose a hazard), the method of attachment is a matter of personal preference.

Since 1987, the National Law Enforcement and Corrections Technology Center (NLECTC) has tested more than 2,600 models of body armor for compliance with NIJ’s ballistic-resistant performance standard. Of these, more than 1,600 comply with the requirements of the NIJ standard and are listed in the *Personal Body Armor Consumer Product List (CPL)*, available from

NLECTC. Testing for compliance with NIJ's stab- and puncture-resistant performance standard began in October 2000. The number of body armor configurations available (including armor designed specifically for female officers) makes it possible for an officer to find comfortable armor suitable for routine use, consistent with his or her personal taste in appearance.

Model and Style Designation

A manufacturer can, and frequently does, use identical ballistic- or stab-resistant panel construction to produce several different configurations of armor, such as an undergarment or an outerwear jacket used by plainclothes officers (e.g., denim jacket, simulated down vest), each of which provides the same level of protection.

For the purposes of the NLECTC body armor compliance procedures, the following definitions have been adopted:

Body armor model. A manufacturer designation (name, number, or other description) that serves to uniquely identify a specific configuration of body armor based on the details of the protective panel construction and the manner in which the armor is held in place on the torso. Separate model designations must be assigned to armor designed to fit the female and male torso.

Body armor style. A manufacturer designation (name, number, or other description) that is used to distinguish between different configurations of body armor product line, each of which is a minor stylistic variation of the same model of ballistic panel but does not have the potential to negatively affect the originally tested ballistic performance level of that model (e.g., the shape of the neckline, coverage, the size of the armhole openings, etc.).

The distinctions between body armor model and style were established to eliminate the need to retest a given body armor model for compliance with the NIJ standards each time a manufacturer incorporates the model into a different style of armor.

The intent of the NIJ program is to ensure that armor purchased for use by criminal justice personnel provides the rated level of protection. However, NIJ recognizes that individual departments often desire minor armor model modifications that do not have the potential to reduce the level of protection. There are a number of variations in configuration that a manufacturer can make to a model without the necessity of assigning a new model number to the modified units. These include:

- 1) Changes in color of the carrier material.
- 2) Changes in the placement of pockets or of straps designed to carry police equipment.

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- 3) Changes in fabric used to encase ballistic panels; provided, however, that if the fabric used in the model tested for compliance was waterproof, the replacement fabric must exhibit equal or improved resistance to water.
- 4) Changes in the fabric of the carrier material; provided, however, that if any portion of the carrier of the sample tested for compliance contained elastic materials such as rubber or foam rubber, the replacement fabric must provide an equivalent amount and thickness of such material to maintain the original energy absorption.
- 5) Changes in the perimeter shape of the ballistic panels, including the shape and size of neck and arm openings, and extending or reducing the overall width of the ballistic panels to increase, decrease, or eliminate overlap of the ballistic panels.
- 6) Changes to the kind, style, or location of fabric attachment and adjustment mechanisms; provided, however, that such changes do not incorporate hard materials that could potentially be a ricochet hazard.
- 7) Changing from a removable panel carrier to one in which the ballistic panel is not removable.

The manufacturer **must assign a new model number and submit the new model for compliance testing** if any of the following modifications are made to a model on the CPL:

- 1) The addition or elimination of any layers of ballistic- or stab-resistant materials of the protective panel resulting in a different number of total layers in the panel.
- 2) Any alteration or changes to the sequence in which the layers are arranged or configured within the ballistic panel for vests consisting of multiple styles or types of materials.
- 3) Any change in the manner in which the ballistic panel is assembled (e.g., the addition or elimination of stitching and changes in stitch density or material).
- 4) Modification of an approved side-opening (solid front/back panels) of the concealable vest to create a front- or back-opening (commonly referred to as “tactical” or “detective” style) vest.
- 5) Changing from a permanent/nonremovable carrier to a removable ballistic carrier.
- 6) Changes to the closure mechanism (including the type or location, interior flaps or panels associated with the mechanism, and any exterior cover device) of front- or back-opening armor configurations.
- 7) Changing from a snug-fitting carrier to one that allows too much movement of the ballistic panel (e.g., ballistic panel sized to fit 38-inch chest inserted in a size-40 carrier).

Modifications not specifically addressed in these guidelines will be reviewed on a case-by-case basis and a determination will be rendered by NIJ. In all cases, the originally tested and archived vest will serve as the benchmark to determine if a change has occurred.

Once a model of armor has been tested and approved, and a letter of compliance has been issued by NLECTC, it becomes the responsibility of the manufacturer to ensure that **all subsequent production units** sold to law enforcement agencies or personnel labeled as being in compliance with NIJ standards are constructed identically to the model submitted to NLECTC for testing and which was found to comply with the requirements of the standards.

ISO 9000

Several armor manufacturers advertise that their companies have obtained ISO 9000 certification. Some confusion exists as to what this certification means and its relationship to NIJ compliance testing. The following explains ISO 9000 and its significance to purchasers.

ISO stands for the International Organization for Standardization. Founded in 1946, its charter calls for it to provide harmonized standards for manufacturing quality that are to be used throughout the world. Through the years, ISO's role has expanded beyond the quality system into environmental issues, occupational health and safety, laboratory accreditations, and conformity assessment. Approximately 110 countries participate in ISO standards programs. International standards are prepared through the efforts of technical committees, working groups, and technical advisory groups.

ISO 9000 defines minimum guidelines for **quality management** in the manufacturing process. This voluntary certification process is designed to provide consistency in the manufacturing process that companies use. Companies are required to have a documented quality control system and their employees must follow these established procedures.

The three quality objectives of ISO 9000 are as follows:

- Achieve and sustain the quality of service so as to meet customer requirements consistently.
- Provide assurance to management that intended quality is achieved and sustained.
- Provide assurance to customers that intended quality is being achieved and sustained.

ISO 9000 has three levels of certification. The basic level, ISO 9003, has 16 requirements. The next level, ISO 9002, requires companies to meet all ISO 9003 requirements, plus servicing, process control, and purchasing requirements. The highest level, ISO 9001, requires companies to meet all the ISO 9002 requirements, as well as documented product design control requirements.

It is important to note that the ISO 9000 certification process certifies the quality control system of companies, not the quality of their products or service. ISO 9000 certification does not imply product conformity to any given set of requirements (such as the NIJ standards). Therefore, a clear and significant distinction exists between manufacturers that are ISO certified

and whether their products comply with the NIJ standards. ISO certification addresses the quality of the manufacturing **process** used by armor manufacturers, while the NIJ standards address the **performance** capabilities of specific models of armor produced by manufacturers.

Materials Used

Note: The following information has been prepared from product literature supplied by the manufacturer. All product descriptions and performance claims are the manufacturer's and do not represent findings or endorsement of these claims by the National Institute of Justice, U.S. Department of Justice; Office of Law Enforcement Standards, U.S. Department of Commerce; or Aspen Systems Corporation.

Several manufacturers have been involved in developing and refining materials used in body armor. DuPont has developed law enforcement protection products for more than 25 years. Its Kevlar® brand fiber, first developed in 1965, was the first material identified for use in the modern generation of concealable body armor. Kevlar® is a manmade organic fiber, with a combination of properties allowing for high strength with low weight, high chemical resistance, and high cut resistance. Kevlar® is also flame resistant; does not melt, soften, or flow; and the fiber is unaffected by immersion in water (see the wet testing discussion in chapter 6 on page 36).

Kevlar® 29, introduced in the early 1970s, was the first generation of bullet-resistant fibers developed by DuPont and helped to make the production of flexible, concealable body armor practical for the first time. In 1988, DuPont introduced the second generation of Kevlar® fiber, known as Kevlar® 129. According to DuPont, this fabric offered increased ballistic protection capabilities against high-energy rounds such as the 9mm full metal jacket (FMJ). In 1995, Kevlar® Correctional™ was introduced, which provides puncture-resistant technology to both law enforcement and correctional officers against puncture-type threats.

The newest addition to the Kevlar® line is Kevlar® Protera, which DuPont made available in 1996. DuPont contends that the Kevlar® Protera is a high-performance fabric that allows lighter weight, more flexibility, and greater ballistic protection in a vest design due to the molecular structure of the fiber. Its tensile strength and energy-absorbing capabilities have been increased by the development of a new spinning process.

DuPont Kevlar® continues to develop and design new generations of high-performance solutions and innovations to provide multithreat protection to officers in the criminal justice community. This patented multithreat technology will enable the creation of armor that protects against firearms, commercially manufactured knives, and puncture-producing weapons like ice picks.

Spectra® fiber, manufactured by Honeywell, is an ultra-high-strength polyethylene fiber. Ultra high molecular weight polyethylene is dissolved in a solvent and spun through a series of small orifices, called spinnerets. This solution is solidified by cooling, and the cooled fiber has a gel-like appearance. Spectra® fiber, which Honeywell claims is the highest strength-to-weight fiber

in the world, is resistant to water penetration, has extremely high chemical resistance and very high cut resistance properties. Honeywell uses its Spectra® fiber to make its patented Spectra Shield® composite. A layer of Spectra Shield® composite consists of two unidirectional layers of Spectra® fiber, arranged to cross each other at 0- and 90-degree angles and held in place by a flexible resin. Both the fiber and resin layers are sealed between two thin sheets of polyethylene film. According to Honeywell, the resulting nonwoven fabric is incredibly strong, lightweight, flexible, and has excellent ballistic protection capabilities. Spectra Shield® is made in a variety of styles for use in both concealable and hard armor applications.

Honeywell also uses the Shield Technology process to manufacture another type of shield composite called GoldFlex®. GoldFlex® is manufactured using aramid fibers in place of the Spectra fiber. GoldFlex®, Spectra Shield®, and Spectra® fabrics offer body armor manufacturers an array of products to meet today's demanding and changing threats.

Another manufacturer, Twaron Products, has developed various forms of its aramid fiber Twaron® for body armor. According to Twaron, this fiber uses 1,000 or more finely spun single filaments that act as an energy sponge, absorbing a bullet's impact and quickly dissipating its energy through engaged and adjacent fibers. Because more filaments are used, the impact is dispersed more quickly. Twaron claims their patented Microfilament technology allows maximum energy absorption at minimum weights while enhancing comfort and flexibility.

Twaron Products maintains that the use of Twaron® in body armor significantly reduces the overall weight of the finished product, thus making vests more comfortable. Twaron Products continues to develop and manufacture lighter weight yarns with finer filaments, expanding their patented Microfilament product line.

Another fiber used to manufacture body armor is Dyneema®. Originated in the Netherlands, Dyneema® has an extremely high strength-to-weight ratio (a 1-mm-diameter rope of Dyneema® can bear up to a 240-kg load), is light enough that it can float on water, and has high energy absorption characteristics.

Zylon®, manufactured by Japanese company, Toyobo, is a PBO (polyphosphazenebenzobisoxazole), a promising new entrant to the high-performance organic fibers market. PBO has outstanding thermal properties and almost twice the tensile strength of conventional para-aramid fibers. According to Toyobo, Zylon® will allow construction of comfortable protective garments because its excellent heat- and mechanical-resistant properties will provide light and flexible fabrics with improved comfort and mobility.

All fibers and materials noted in this chapter have a wide variety of uses in addition to ballistic garments. They are used for other types of protective clothing and equipment (e.g., bicycle and skateboarding helmets), marine and aircraft components, industrial cables, and recreational equipment such as fishing rods and tennis rackets. The materials described are some of the most commonly used; other materials (e.g., ballistic nylon) can also be used.

The introduction of newer, high-performance fibers has dramatically decreased the weight and bulk of today's body armor and increased its comfort and wearability. It can be anticipated that newer materials will be developed and in conjunction with further advances in ballistic vest design, technology will continue to enhance the performance and comfort of tomorrow's body armor.

5. The NIJ Standards

The National Institute of Justice (NIJ) standards for *Ballistic Resistance of Personal Body Armor* and *Stab Resistance of Personal Body Armor* were developed by the National Institute of Standards and Technology's (NIST's) Office of Law Enforcement Standards (OLES) and issued by NIJ as voluntary national standards. These are performance rather than design standards, as are most OLES standards. Performance standards clearly specify a minimum satisfactory level of performance for each attribute that is critical to the equipment's intended use. In contrast, design standards specify the manner in which an item of equipment must be manufactured. Performance standards encourage design innovation and the use of advanced technology, addressing critical requirements only and not such attributes as comfort, color, or style—which are generally matters of user perception or preference.

The administrative procedures for NIJ's body armor compliance-testing program, which is administered by the National Law Enforcement and Corrections Technology Center (NLECTC), are designed to ensure the integrity of the test results. A series of pre- and post-test checks and balances ensure the laboratory's conformance to the NIJ testing procedure. When a manufacturer elects to have a model of armor tested, the test samples are delivered to NLECTC, where the labels and workmanship are inspected before the samples are given to an independent laboratory for testing. A 2-week period is allocated to accomplish the control function before the scheduled testing date. Following testing, the samples are returned to NLECTC, where test results are verified. The tested samples are then archived.

The NIJ body armor testing program relies on voluntary participation by manufacturers. However, many police departments require that armor be tested by NLECTC and found in compliance with NIJ standards before they purchase the armor. As a result, most manufacturers design their armor to comply with the standards and have each model tested for compliance by NLECTC. Whenever NIJ develops a new standard, NLECTC distributes the revision to industry representatives for their comments.

Developing the NIJ Standard for Ballistic Resistance of Personal Body Armor

The selection of body armor has become increasingly complex as manufacturers have developed numerous models and designs, the variety of ballistic fabric styles has increased, and the protection requirements of police agencies have changed. All of these factors have necessitated changes in the NIJ body armor standard.

NIJ's first standard, 0101.00, *Ballistic Resistance of Police Body Armor*, was published in March 1972 in response to the law enforcement community's request for a benchmark against which to measure competing manufacturer claims. This first standard provided requirements only for resistance to actual penetration of the vest by a bullet and defined only three levels of

protection from various threats. The issue of whether the armor could prevent injury from blunt trauma was not addressed.

In 1975, NIJ requested that the Law Enforcement Standards Laboratory (LESL), the predecessor to OLES, begin revision of the first standard to reflect contemporary research on blunt trauma and the degradation of armor when wet. A revised standard, STD-0101.01,¹³ was published in December 1978 to introduce the backface signature test for blunt trauma and wet testing.

At approximately the same time, the law enforcement community asked NIJ to establish an equipment testing program to provide independent verification of body armor compliance to the NIJ standard. NIJ entered into a cooperative agreement with the International Association of Chiefs of Police (IACP) to conduct the testing. The first results were published in 1978. Since then, the models and the names of their manufacturers that pass compliance testing have been published in the *Police Body Armor Consumer Product List*, now known as the *Personal Body Armor Consumer Product List (CPL)*, which since 1999 has been available electronically through the NLECTC Web site, JUSTNET, at <http://www.justnet.org>. NLECTC also publishes other documents and guides, such as this one, to help police departments select and procure body armor.

In March 1985, NIJ amended the standard, issuing STD-0101.02, to take into account armors' susceptibility to angle shots and multishot assaults. NIJ STD-0101.02 also introduced threat level III-A, the highest protection level in concealable armor, in response to concerns from the law enforcement community about the need for protection from high-velocity and high-energy handgun rounds such as the submachine gun 9mm and .44 Magnum.¹⁴ Published in April 1987, STD-0101.03 clarified labeling requirements, acceptance criteria, and backface signature measurement procedures.¹⁵ NIJ also strengthened its administrative procedures for archiving models.

The Current Standard, NIJ Standard-0101.04

In September 2000, NIJ issued *Ballistic Resistance of Personal Body Armor*, NIJ Standard-0101.04¹⁶ the first revision in 13 years. There were a number of reasons for the revision. Since 1987, when the 0101.03 standard was adopted, there have been many changes in the design, manufacturing, and use of body armor. The ammunition and weapons threats that police officers face are different. Most officers today use autoloading pistols as their duty weapon instead of revolvers. Design technology used in making the vests has changed significantly, and new ballistic-resistant materials have been introduced. Administrative changes added to the NIJ standard over time have also made it unduly cumbersome for laboratory test personnel to administer the test. The revised standard reflects the changes in threats and designs and incorporates and streamlines the administrative changes. Testing under the revised standard was initiated in fall 2000.

The new 0101.04 standard represents a significant step toward ensuring consistent, well-documented testing of body armor under NIJ's program. The main intent of the revision was to

incorporate as many of the lessons learned from the long period of 0101.03 testing experience as possible, particularly in regard to clarification and definition of many of the methods and equipment used to test body armor for NIJ compliance.

In addition to the introduction of new test threat rounds, the new standard reinstates the “pat down” procedure or the smoothing of the armor panel between shots, which was performed in NIJ Standard–0101.02 and previous editions, and an increase from one to two measurements per panel for backface signature. The techniques and equipment for wet conditioning of the test armor, construction of the backing material fixture, and firing the test threat ammunition also have been updated and revised. A single, highly automated, computer-based reporting format and comprehensive database archival system will standardize reports, making testing data more manageable and accessible to users.

Introducing Stab Resistance of Personal Body Armor, NIJ Standard–0115.00

While the most common type of threat faced by a police officers is from a gun, the most common threat a correctional officer is likely to face is from a knife or ice pick. In response to the needs of the corrections community, NIJ has developed a performance standard for stab- and puncture-resistant body armor through a collaboration of OLES, the U.S. Secret Service, and the Police Scientific Development Branch (PSDB) in the United Kingdom (UK). *Stab Resistance of Personal Body Armor, NIJ Standard–0115.00*¹⁷ was released in October 2000.

This standard specifies the minimum performance requirements for body armor that is resistant to attack by typical pointed and edged weapons. The standard also describes the test methodology to be used for this assessment.

In developing the standard, NIJ relied on the extensive research experience of PSDB in the UK, where the primary threat to law enforcement officers is from sharp-edged and pointed weapons. As part of their initial research, PSDB created a model to determine the actual forces generated by an assailant during attack, and, from this model, developed realistic test methodologies and procedures that could be replicated in the laboratory. Several different types of blades were engineered to accurately reflect actual threats faced by law enforcement and correctional officers. Although these blades are specially designed to ensure consistency in testing procedures, they reflect many of the features found in the high-grade commercial knives or homemade instruments most commonly used in attacks.

The threats from ice picks and lower quality, prison-made knives and shivs are much more difficult to quantify than those from commercial knives. Research addressing homemade instruments continues, and any improvements from this research will be incorporated into future revisions of NIJ Standard–0115.00. For the present time, the same test methodology will be used for homemade weapons as is used for commercial knives, but the threat weapon

is a modified ice pick commonly used in the “California Ice Pick” test. A more complete discussion of the testing procedures, protection classes, and threat levels can be found in chapter 7.

This standard and the revised standard for ballistic-resistant body armor were circulated for review among the membership of the Law Enforcement and Corrections Technology Advisory Council (LECTAC), LECTAC’s Weapons and Protective Systems Subcommittee, LECTAC’s Executive Committee, and the National Armor Advisory Board (NAAB). NAAB is made up of law enforcement officers and body armor industry representatives, including fiber and fabric manufacturers, weavers, and armor manufacturers.

NIJ’s policy on body armor has always been that preserving the life of the police or corrections officer is the sole criterion on which to judge body armor effectiveness. At present, an officer may select a garment that corresponds to an appropriate threat level and be confident that armor in compliance with NIJ’s standard will defeat the stated threat level.

Cooperative Efforts Between NLECTC and Industry

To further enhance its mission to support State and local law enforcement and corrections by identifying their needs, finding expedient and cost-effective solutions, and bringing those solutions to the attention of the law enforcement and corrections community, NIJ has developed a new cooperative effort between NLECTC and the body armor industry. The existing NLECTC program structure accomplishes this by refining the process for developing policy and by reviewing standards (see exhibit 3).

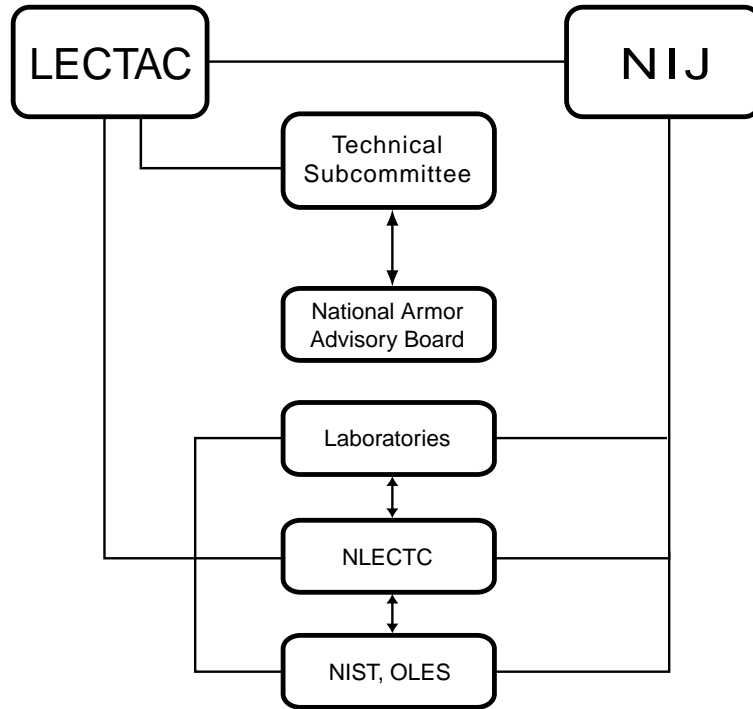
Key organizational components of NLECTC’s policy development process are NIJ, LECTAC, NLECTC, OLES, LECTAC’s technical subcommittees, and the testing laboratories. Industry’s role has been formalized through the introduction of advisory boards, whose functions are included below.

NIJ. The Institute funds and manages all the activities of NLECTC, resolves disputes and appeals, conducts needs assessments, and coordinates input from the criminal justice system.

LECTAC. A key element in the policy and standards development process, LECTAC is composed of Federal, State, and local law enforcement and corrections professionals who are appointed by NLECTC with the approval of the LECTAC Executive Committee. LECTAC meets at least annually, and its chairperson keeps in close contact with NIJ and NLECTC throughout the year. The advisory council:

- Identifies critical product and technology needs of the criminal justice community.
- Recommends priorities and methods that form the basis from which standards and policies are developed.
- Assesses law enforcement and corrections equipment issues, including suggesting research and development priorities.

Exhibit 3: Policy Structure



- Suggests equipment to be tested and recommends the development of guides, bulletins, and other program publications.
- Strengthens links between NIJ and the criminal justice community.

LECTAC subcommittees. LECTAC’s subcommittees report to the full council and meet on an as-needed basis. Subcommittees are formed to address major areas of technology research and development such as law enforcement and corrections operations, weapons and protective systems, communications, and contraband detection, among others. The chair of a subcommittee also serves as or appoints the chair of any advisory board assigned to that subcommittee.

NLECTC. NLECTC coordinates the testing of all equipment under the program and fields requests for information and technical assistance from law enforcement and corrections agencies. The criminal justice community looks to NLECTC for authoritative information on the latest technology and products. NLECTC:

- Coordinates equipment testing activities and collects results from laboratories.
- Publishes consumer product lists of products that comply with NIJ standards.
- Operates a toll-free information service and Internet site.

- Archives tested products.
- Issues publications on equipment and standards.
- Provides technical assistance to the criminal justice community.
- Serves as a resource to LECTAC and the advisory boards.

OLES. Funded by NIJ through an interagency agreement, OLES is part of NIST. As NIJ's principal agent for setting standards on law enforcement equipment, OLES:

- Conducts technical studies.
- Develops initial standards for testing and provides scientific and technical support to the technical committees and advisory boards.
- Provides technical assistance to criminal justice agencies.
- Evaluates and monitors testing laboratories.

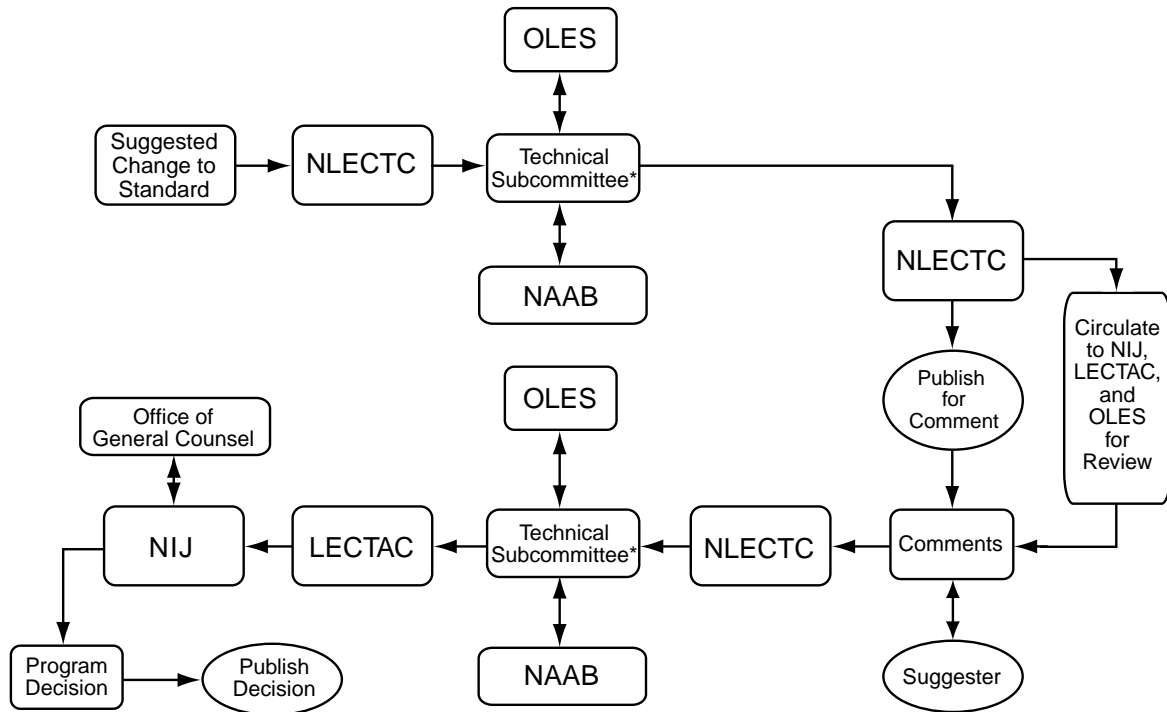
Testing laboratories. Independent testing laboratories are evaluated by OLES and subsequently authorized by NLECTC to conduct testing of manufacturers' products in accordance with NIJ standards. Each product is tested before appearing in a *Personal Body Armor CPL*. The testing itself is contracted between the manufacturer and the laboratory, but the equipment must be submitted through NLECTC. Once a performance assurance program has been developed, laboratories selected by NLECTC to test body armor will be required to provide the manufacturers with a followup performance assurance program.

Advisory boards. Composed of industry and user representatives, NLECTC intends to establish advisory boards for each major equipment/technology focus that will report to the respective technical subcommittees of LECTAC. The boards will provide an opportunity for the industry and users to meet directly with LECTAC technical subcommittees. Currently, NAAB is the only advisory board that has been formed. It is composed of body armor manufacturers, fiber and fabric manufacturers, law enforcement management, and rank-and-file representatives from law enforcement. Board members review standards and policy and recommend revisions to the Weapons and Protective Systems Subcommittee of LECTAC. All advisory boards will recommend actions concerning possible modifications of NIJ standards. If an advisory board endorses a recommendation to their respective subcommittee, it will be referred to LECTAC for its full endorsement.

The Standards Review Process

With advice from NAAB, NLECTC, and the Weapons and Protective Systems Subcommittee of LECTAC, NIJ has formalized a process for accommodating changes to the existing body armor standard. In this revised process, shown in exhibit 4, a suggestion for a change in the standard is

Exhibit 4: Standards Review Process



*LECTAC's Weapons and Protective Systems Subcommittee.

submitted to NLECTC. NLECTC then conducts an immediate review to ensure that the suggestion is intelligible, relevant to the equipment in question, and has not been considered previously.

If the suggestion passes this review, copies are forwarded to the Weapons and Protective Systems Subcommittee and NAAB. If the suggestion has technical merit and is feasible, the subcommittee directs NLECTC to publish the suggestion and to solicit comments from the field. NLECTC also circulates the suggested change to NIJ, LECTAC, and OLES for review.

Comments from the field regarding the recommendations are provided to NLECTC in a specified number of copies. Copies are also provided by the commenter directly to the person or organization who made the suggestion. NLECTC forwards the comments, along with its recommendations regarding the comments, to NIJ, OLES, the Weapons and Protective System Subcommittee, and NAAB for review. The subcommittee then makes a final recommendation to LECTAC, which passes it on to NIJ. NIJ and the Office of General Counsel review the recommendation to ensure that it fully complies with the law and relevant policy. If it does, NLECTC publishes the decision and the effective date of the change.

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The following options are available to the reviewers when they consider a suggestion:

- Accept the suggestion as offered.
- Accept the suggestion with modifications.
- Refer the suggestion for further research.
- Reject the suggestion because it was improperly submitted, previously rejected, irrelevant, or not feasible.

Suggestions are processed at least annually. If a suggestion is rejected, an explanation is provided. NIJ does not consider revising the standard unless supporting research is presented, nor does NIJ change the standard without comments from law enforcement and the body armor industry. If NIJ errs, it is on the side of the user. The standards review process is similar for other equipment standards.

NIJ's responsiveness to law enforcement and industry concerns is evident in recent changes in the program. These changes include strengthening the program's management and policy structure, creating a process for modifying standards, inviting industry representatives to participate in the standards review process, and sending letters to manufacturers to clarify the responsibilities of those who choose to participate in the body armor program. (This last step is to prevent confusion and misunderstandings that might develop in the use of the NIJ standard and testing program for manufacturers' product advertising and marketing.)

NIJ is proud of the partnership it is forging among government, industry, and the Nation's police and corrections officers. Like all partnerships, the one between NIJ and body armor manufacturers must be based on mutual rights and responsibilities. In return for permission to use the NIJ label, NIJ also asks manufacturers to take responsibility for the safety of their products that are sold to law enforcement officers. Reciprocally, NIJ is committed to working with the manufacturers to adjust the standards and testing program to accommodate the needs and technological advancements of the body armor industry.

6. Ballistic-Resistant Personal Body Armor

Selecting the Appropriate Level of Protection

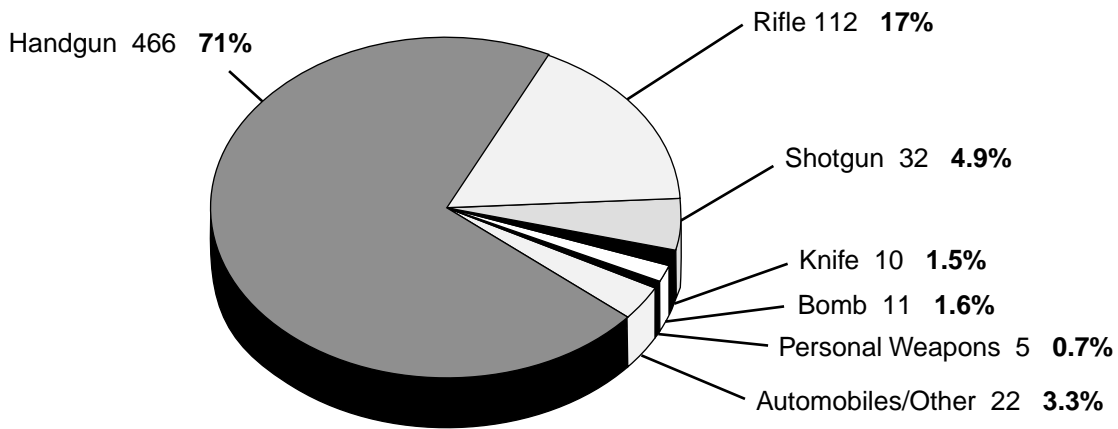
The first step in selecting the appropriate protection level of body armor is to establish the level of protection that users need based on the realistic weapon threat they face. To date, body armor has not been known to fail to prevent the penetration of a bullet constituting a threat equal to or less than the protection rating of the armor. However, officers have died from wounds received from weapons or ammunition exceeding the rated protection of the armor. While 100-percent protection in all circumstances is impossible, the routine use of appropriate body armor significantly reduces the likelihood of fatal injury. Body armor selection is to some extent a tradeoff between ballistic protection and wearability. The weight and bulk of body armor are generally proportional to the level of ballistic protection it provides; therefore, comfort decreases as the protection level increases. All departments should strive to select body armor that their officers will wear, consistent with their ballistic protection requirements. Agencies should ensure that each officer knows and understands the protection that it affords, as well as its limitations.

The weapons and ammunition commonly found on the street may vary significantly with geographic location. Therefore, information concerning weapons and ammunition that are confiscated in both the local jurisdiction and nearby surrounding areas must be considered, as well as statistics concerning gun sales by local firearms dealers. Such data will permit an assessment of the current threat from street weapons. The National Institute of Justice (NIJ) strongly recommends the selection of an armor that protects against both the street threat and the officer's handgun. A review of reports on officers killed during the period from 1980 to 2000 shows that 163 of the 1,058 officers killed with a handgun, or on average one in six officers, was killed with his or her own service weapon.

Information from the Uniform Crime Reports (UCR), *Law Enforcement Officers Killed and Assaulted*¹⁸ provides some insight into the overall threat to officers nationwide. Statistics based on the Federal Bureau of Investigation's (FBI's) UCR data reveal that from 1990 to 1999, 658 law enforcement officers were feloniously killed in the line of duty (see exhibit 5). Of these, 610 (92.7 percent) were killed by firearms—466 (71 percent) by handguns, 112 (17 percent) by rifles, 32 (4.9 percent) by shotguns—and 48 (7 percent) by other types of weapons. These other weapons included knives (10 fatalities); bombs (11, 8 of which occurred in a single incident—the bombing of the Alfred P. Murrah Federal Building in Oklahoma City); personal weapons (5); and automobiles and other fatal means not usually thought of as weapons (22).

Of the 466 deaths from handguns, between 1990 and 1999, 9mm handguns or lesser handguns were used in 311 (66.7 percent) of the cases.

Exhibit 5: Law Enforcement Officers Feloniously Killed 1990–1999



Source: FBI Uniform Crime Reports: *Law Enforcement Officers Killed and Assaulted 1999*

The “Takeaway” Problem

Another consideration in determining the appropriate threat level is the type of service weapon and ammunition used by the department. In reviewing the UCR data for the time period of 1980 to 1999, a total of 163 deaths, or 15.4 percent of deaths from handguns, resulted from officers being shot with their own service weapon (see exhibit 6). In these 163 cases, no documented incidents occurred of a round from the officer’s service weapon penetrating the officer’s body armor and causing the fatal injury.

A dramatic decline has occurred in the number of officers slain with their own weapons in the 1990s. For the period from 1980 to 1989, an average of 11.2 officers were slain annually with their own weapons; from 1990 to 1999, the average decreased to 5.2 officers. This decrease can most likely be attributed to several factors, including increased officer awareness of the problem, expanded use of body armor, enhanced officer safety and weapon retention training, and the emergence of holsters designed with security or antitakeaway features. However, officers should still be cognizant of the potential danger posed by their own sidearms, should these be used against them. Generally speaking, Type II-A and Type II armor provide protection against most types of handgun ammunition commonly used by law enforcement agencies today.

In analyzing potential weapon threats, a given police department will probably identify several threat levels, depending on the nature of specific assignments. Specialized armor will be required for special weapons and tactics team operations, but these armors will only be issued and used as needed. As noted earlier, armor that provides protection against high-level threats

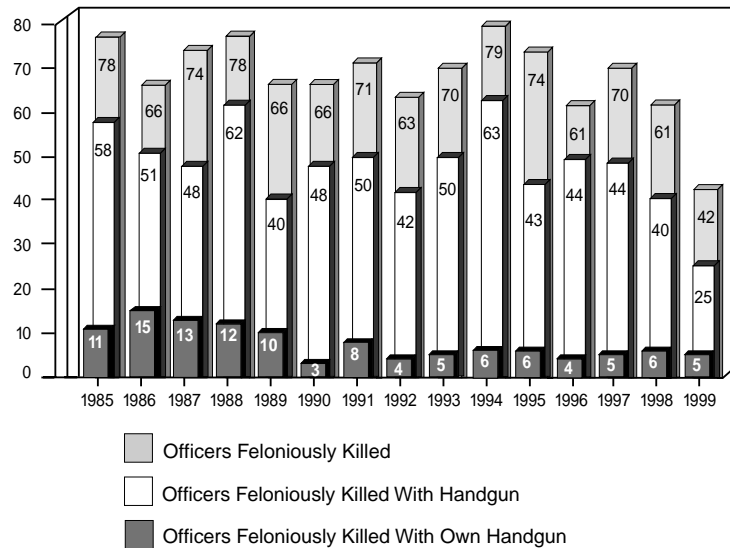
is generally heavy and bulky and therefore can be unsuitable for full-time use.

A department should avoid the temptation to purchase armor that provides protection far in excess of realistic needs. Such a purchase not only increases the cost, but increases the likelihood that the armor will not be worn. Overspecification of protection levels has been alleged as the most common reason that armor is not worn.

Recognizing that it may not be practical to protect against all possible handgun attacks, a department must carefully consider the selection of armor appropriate to its needs. In the final analysis,

those responsible for selecting the level of protection for armor to be used routinely must exercise prudent judgment and decide whether the overall benefits of limited protection (purchasing a less protective armor type than the maximum level of protection indicated by threat analysis) outweigh the complete loss of protection if the armor is not worn.

Exhibit 6: Officers Slain With Own Firearm Versus Total Officers Slain 1985–1999



Source: FBI Uniform Crime Reports: *Law Enforcement Officers Killed and Assaulted 1994–1999 (Annual Reports)*

The Corrections Threat

While the FBI’s Uniform Crime Reports *Law Enforcement Officers Killed and Assaulted (LEOKA)* provides detailed insight into the nature and types of assaults on police officers, there are no comparable statistics currently maintained for assaults on corrections officers. However, the statistics that are available indicate that the threat of assault is a common danger for corrections officers as well.

According to data compiled by the Bureau of Justice Statistics (BJS), between 1990 and 1997 the number of inmates in State and Federal custody has increased by a total of 434,000, or an average annual growth rate of 6.8 percent.¹⁹ There was a one-third increase in the number of assaults by inmates on corrections facility staff between 1990 and 1995. In 1990, there were 10,731 reported assaults by inmates on corrections facility staff; in 1995, there were 14,165 reported assaults. The nature of the assaults has become more severe as well. In 1990, none of

the reported assaults resulted in the death of the staff member who was assaulted. By comparison, in 1995, 14 staff members were killed as a result of the assault.²⁰

While the threat faced by the police officer is most frequently from firearms, a corrections officer faces an entirely different variety of threats. Because corrections officers are rarely equipped with firearms, and it is extremely rare for an inmate to obtain a firearm within a correctional facility, the most common threat faced is from pointed- and sharp-edged weapons. Most of these are homemade or improvised weapons, made from scraps of metal obtained through a variety of sources in the corrections environment.

While these threats are different from firearms, they are equally capable of inflicting serious or fatal injuries. Until recently, many protective garments designed for use against corrections threats were much heavier and bulkier than the ballistic-resistant counterparts worn by police officers, as materials technology generally did not allow for a protective vest for corrections applications to be made entirely of woven materials. Quite frequently, these vests incorporated thin sheets of metal and other types of hard plating to protect against typical corrections threats. However, in recent years significant breakthroughs in materials technology have made it possible for corrections officers to have access to stab- and puncture-resistant vests that are similar in weight and bulk to the ballistic-resistant vests worn by their police counterparts. It is anticipated that as these vests become more commonplace in the corrections workplace, corrections officer fatalities will decrease as police officer fatalities decreased after the introduction of ballistic-resistant armor in the mid- to late 1970s.

Armor Classifications for Ballistic-Resistant Armor

NIJ Standard-0101.04 establishes six formal armor classification types, as well as a seventh special type, as follows:

Type I (.22 LR; .380 ACP). This armor protects against .22 long rifle lead round nose (LR LRN) bullets, with nominal masses of 2.6 g (40 gr), impacting at a minimum velocity of 320 m/s (1050 ft/s) or less, and against .380 ACP full metal jacketed round nose (FMJ RN), with nominal masses of 6.2 g (95 gr), impacting at a minimum velocity of 312 m/s (1025 ft/s) or less.

Type I body armor is light. This is the minimum level of protection every officer should have, and the armor should be routinely worn at all times while on duty. Type I body armor was the armor issued during the NIJ demonstration project in the mid-1970s. Most agencies today, however, because of increasing threats, opt for a higher level of protection.

Type II-A (9mm; .40 S&W). This armor protects against 9mm full metal jacketed round nose (FMJ RN) bullets, with nominal masses of 8.0 g (124 gr), impacting at a minimum velocity of 332 m/s (1090 ft/s) or less, and .40 S&W caliber full metal jacketed (FMJ) bullets, with

nominal masses of 11.7 g (180 gr), impacting at a minimum velocity of 312 m/s (1025 ft/s) or less. It also provides protection against Type I threats.

Type II-A body armor is well suited for full-time use by police departments, particularly those seeking protection for their officers from lower velocity 9mm and 40 S&W ammunition.

Type II (9mm; .357 Magnum). This armor protects against 9mm full metal jacketed round nose (FMJ RN) bullets, with nominal masses of 8.0 g (124 gr), impacting at a minimum velocity of 358 m/s (1175 ft/s) or less, and .357 Magnum jacketed soft point (JSP) bullets, with nominal masses of 10.2 g (158 gr), impacting at a minimum velocity of 427 m/s (1400 ft/s) or less. It also provides protection against Type I and Type IIA threats.

Type II body armor is heavier and more bulky than either Types I or II-A. It is worn full time by officers seeking protection against higher velocity .357 Magnum and 9mm ammunition.

Type III-A (High Velocity 9mm; .44 Magnum). This armor protects against 9mm full metal jacketed round nose (FJM RN) bullets, with nominal masses of 8.0 g (124 gr), impacting at a minimum velocity of 427 m/s (1400 ft/s) or less, and .44 Magnum jacketed hollow point (JHP) bullets, with nominal masses of 15.6 g (240 gr), impacting at a minimum velocity of 427 m/s (1400 ft/s) or less. It also provides protection against most handgun threats, as well as the Type I, II-A, and II threats.

Type III-A body armor provides the highest level of protection currently available from concealable body armor and is generally suitable for routine wear in many situations. However, departments located in hot, humid climates may need to evaluate the use of Type III-A armor carefully.

Type III (Rifles). This armor protects against 7.62mm full metal jacketed (FMJ) bullets (U.S. military designation M80), with nominal masses of 9.6 g (148 gr), impacting at a minimum velocity of 838 m/s (2750 ft/s) or less. It also provides protection against Type I through III-A threats.

Type III body armor is clearly intended only for tactical situations when the threat warrants such protection, such as barricade confrontations involving sporting rifles.

Type IV (Armor Piercing Rifle). This armor protects against .30 caliber armor piercing (AP) bullets (U.S. military designation M2 AP), with nominal masses of 10.8 g (166 gr), impacting at a minimum velocity of 869 m/s (2850 ft/s) or less. It also provides at least single-hit protection against the Type I through III threats.

Type IV body armor provides the highest level of protection currently available. Because this armor is intended to resist “armor piercing” bullets, it often uses ceramic materials. Such materials are brittle in nature and may provide only single-shot protection, since the ceramic tends to break up when struck. As with Type III armor, Type IV armor is clearly intended only for tactical situations when the threat warrants such protection.

Special type. A purchaser who has a special requirement for a level of protection other than one of the above standard threat levels should specify the exact test rounds and minimum impact velocities to be used and indicate that this standard shall govern in all other respects.

Requirements

The performance requirements of NIJ Standard–0101.04, which were developed with the active participation of body armor manufacturers, ensure that each armor type will provide a well-defined minimum level of ballistic protection.

Exhibit 7, reproduced from the standard, identifies the specific bullets and impact velocities that each armor type must withstand.

Types I, II–A, II, and III–A armor are required to prevent penetration from the impact of six bullets per panel, for two complete samples (front and back panels) at specified velocities and locations for two types of ammunition. Two of the impacts in each six-shot sequence must be at a 30-degree angle. A total of 48 shots are completed on four samples. Furthermore, the deformation of the backing material (a measure of blunt trauma protection) must not exceed 44mm (1.73 in). Deformation readings are taken on each panel at shot location 1, then at either shot location 2 or 3, whichever one had the highest shot velocity. The armor must meet these requirements while wet.

Type III armor requirements are identical to those above, except that only one type of ammunition is specified, and all six test rounds are fired perpendicular to the surface of the armor. A total of 12 shots are completed (6 shots per sample).

Type IV armor is required to resist penetration from only a single type of ammunition (armor piercing) and is only required to prevent penetration and backface deformation greater than 44mm (1.73 in) from a single perpendicular impact. A total of two samples are tested.

In addition to the ballistic requirements, the NIJ standard requires quality workmanship and specifies the minimum information that must be included on the armor's label. The maximum allowable deformation of the clay-backing material was determined through an extensive series of ballistic gelatin measurements and experiments conducted by a team of medical experts. This limit ensures protection from blunt trauma that arises from an impact occurring over vital locations. Even this level of protection, however, does not give an absolute guarantee of protection against internal injuries.

The rationale for the requirement that armor resist bullet penetration is obvious. The reasons for other ballistic requirements may not be apparent.

Wet testing. Certain ballistic fabrics lose ballistic-resistant efficiency when wet, but fully return to normal ballistic efficiency upon drying. Laboratory tests of non-water-repellent treated vests soaked in water have shown a reduction in ballistic efficiency of more than 20 percent

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Exhibit 7: Test Summary (NIJ Standard–0101.04)

Armor Type	Test Variables				Performance Requirements						
	Test Round	Test Bullet	Bullet Weight	Reference Velocity (± 30 ft/s)	Hits Per Armor Part at 0° Angle of Incidence	BFS Depth Maximum	Hits Per Armor Part at 30° Angle of Incidence	Shots Per Panel	Shots Per Sample	Shots Per Threat	Total Shots Req'd
I	1	.22 caliber LR LRN	2.6 g 40 gr.	329 m/s (1080 ft/s)	4	44 mm (1.73 in)	2	6	12	24	48
	2	.380 ACP FMJ RN	6.2 g 95 gr.	322 m/s (1055 ft/s)	4	44 mm (1.73 in)	2	6	12	24	
IIA	1	9 mm FMJ RN	8.0 g 124 gr.	341 m/s (1120 ft/s)	4	44 mm (1.73 in)	2	6	12	24	48
	2	.40 S&W FMJ	11.7 g 180 gr.	322 m/s (1055 ft/s)	4	44 mm (1.73 in)	2	6	12	24	
II	1	9 mm FMJ RN	8.0 g 124 gr.	367 m/s (1205 ft/s)	4	44 mm (1.73 in)	2	6	12	24	48
	2	.357 Mag JSP	10.2 g 158 gr.	436 m/s (1430 ft/s)	4	44 mm (1.73 in)	2	6	12	24	
IIIA	1	9 mm FMJ RN	8.2 g 124 gr.	436 m/s (1430 ft/s)	4	44 mm (1.73 in)	2	6	12	24	48
	2	.44 Mag SJHP	15.6 g 240 gr.	436 m/s (1430 ft/s)	4	44 mm (1.73 in)	2	6	12	24	
III	1	7.62 mm NATO FMJ	9.6 g 148 gr.	847 m/s (2780 ft/s)	6	44 mm (1.73 in)	0	6	12	12	12
IV	1	.30 caliber M2 AP	10.8 g 166 gr.	878 m/s (2880 ft/s)	1	44 mm (1.73 in)	0	1	2	2	2
Special	*	*	*	*	*	44 mm (1.73 in)	*	*	*	*	*

*These items must be specified by the user.

Panel = Front or back component of typical armor sample.

Sample = Full armor garment, including all component panels (F&B).

Threat = Test ammunition round by caliber.

Notes: Armor parts covering the torso front and torso back, with or without side coverage, shall each be impacted with the indicated number of fair hits. Armor parts covering the groin and coccyx shall each be impacted with three fair hits at 0° angle of incidence. The deformation due to the first fair hit shall be measured to determine compliance. No fair hit bullet or one impacting at a velocity lower than the minimum required bullet velocity shall penetrate the armor.

Abbreviations: AP—Armor Piercing
 FMJ—Full Metal Jacket
 JSP—Jacketed Soft Point
 LRHV—Long Rifle High Velocity
 RN—Round Nose
 SJHP—Semi-Jacketed Hollow Point
 SWC—Semi-Wadcutter

compared to that of dry vests. The cause of this phenomenon is not known, but it is theorized that water acts as a lubricant, which allows the bullet to pass through the fibers more easily.

An officer may confront an armed assailant in the rain, and body perspiration can also significantly reduce the ballistic efficiency of untreated fabrics. Laboratory tests conducted by the U.S. Army Natick R&D Command, using a mannequin that simulates human perspiration, verified that vests will absorb perspiration in amounts comparable to a vest that has been allowed to drain following immersion in water. A series of tests was also conducted by a research team from the U.S. Department of Justice, in which officers wearing untreated vests were subjected to strenuous exercise on a hot humid day. The amount of perspiration in the vests corresponded to the Natick experiments, and when ballistic tests were conducted, a significant reduction in the efficiency was noted. In view of this, the NIJ standard requires that a vest continue to provide the rated level of ballistic protection when wet.

The vast majority of body armor manufactured today uses materials that (1) are inherently waterproof or are treated with water repellants; (2) have a permanent water-repellant covering (such as rip-stop nylon); or (3) both. However, the standard requires wet testing to ensure that these vests still provide adequate protection in situations in which they are exposed to moisture.

Those purchasing body armor should be aware that some manufacturers offer models that are supposedly identical in construction to NIJ-tested and -approved models, except that they do not have the water-repellant treatment. NIJ considers the removal or alteration of water-repellant treatment to be a change in the design of the vest. NIJ does not, under any circumstances, recognize any model that “partially” complies with the standard.

Angle shots. All Type I through Type III-A body armors are required to resist the penetration of bullets striking at an angle to the surface, because the probability of being hit exactly perpendicular to the surface is low. Certain fabrics are less efficient ballistically by as much as 20 percent when a bullet strikes at an angle. Armor must provide the rated level of protection regardless of the angle of impact.

Performance Testing

As a service to law enforcement, corrections, and manufacturers, NIJ’s body armor compliance testing program tests body armor using independent testing laboratories to determine compliance with the requirements of NIJ Standard–0101.04. The models that comply with the requirements of this NIJ standard are added to its *Personal Body Armor Consumer Product List (CPL)*, which is widely distributed to law enforcement agencies as a procurement aid.

Exhibit 8, from NIJ Standard–0101.04, shows the test setup for ballistic testing of police body armor. The chronograph measures the bullet velocity to ensure that each test round is within the range required by the standard. The armor being tested is mounted on a clay-backing material whose consistency is controlled.

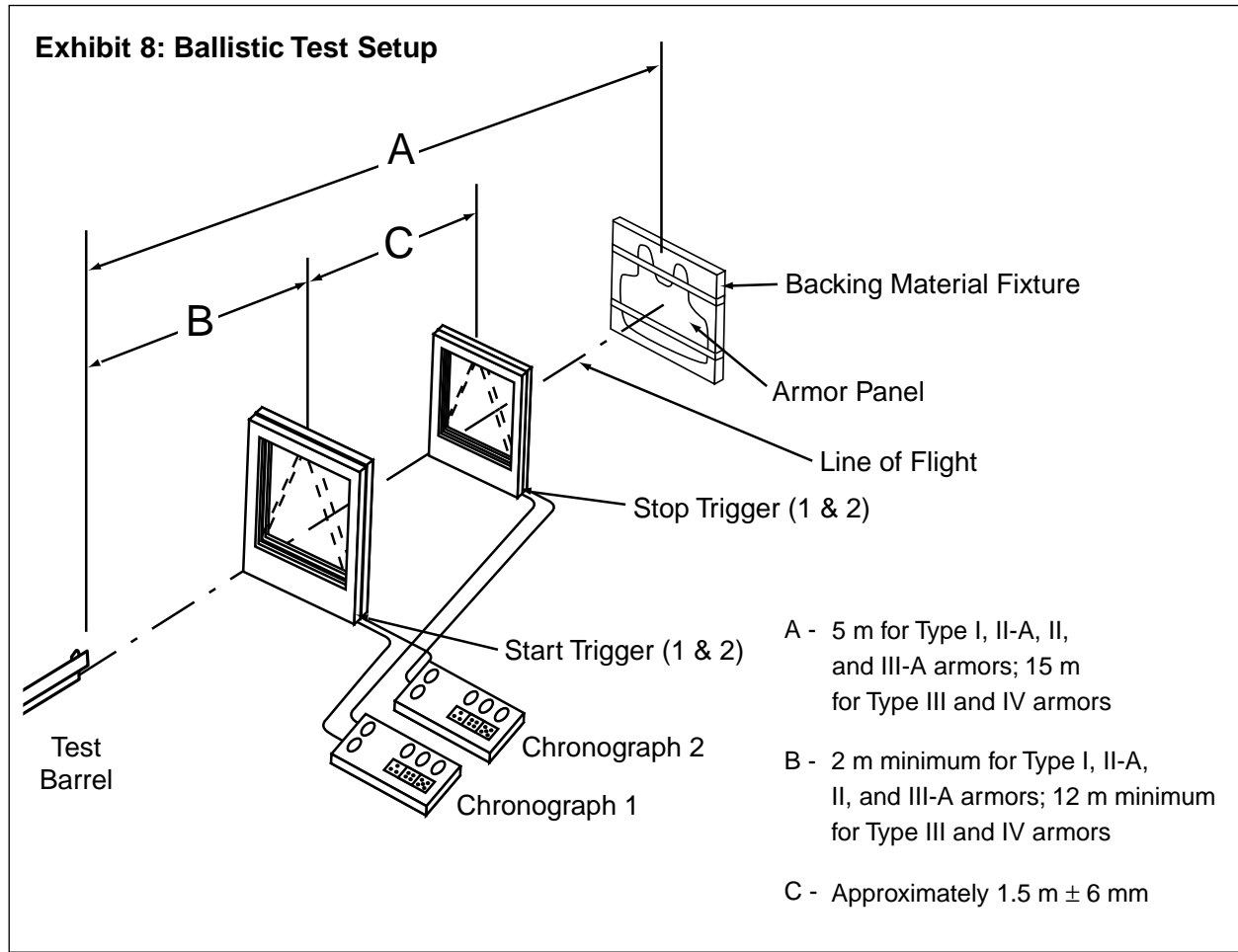
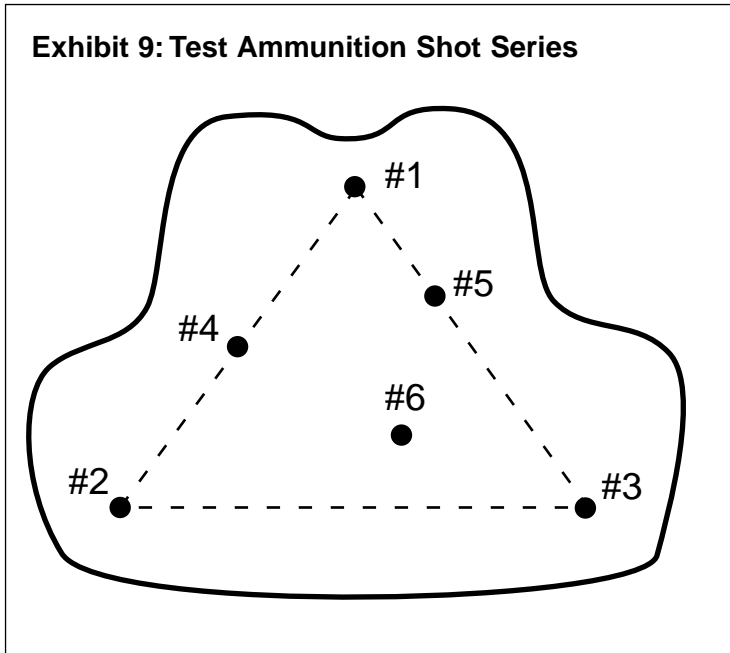


Exhibit 9, also from NIJ Standard-0101.04, shows the general locations of points of impact for each round fired in the six-shot sequence for each type of ammunition specified in exhibit 7 for the type of armor being tested. The deformation of the clay behind the impact of the first shot (location 1) is measured to determine compliance with the blunt trauma requirement. Following the deformation measurement, the armor is repositioned on the clay and the remaining five shots are fired, two of which (locations 5 and 6) are fired at an angle of 30 degrees to the armor surface. The armor is smoothed out, or "patted down," after each shot. After the first shot is taken, the panel is removed from the test fixture and the clay is trimmed, or "struck," back to its original level surface. A second deformation measurement is taken at either shot number 2 or number 3, depending on which shot had the highest velocity.

The armor is tested after being sprayed with a measured quantity of water for 3 minutes on each side before being mounted on the clay. Both the front and back of the armor are tested, and, if present, tests are conducted on groin and coccyx (end of spine) protection panels.

Exhibit 9: Test Ammunition Shot Series

The clay-backing material must be properly conditioned and must meet the requirements specified in the standard, as the only current means of relating deformation to blunt trauma protection. Some departments attempt to conduct their own tests using a variety of backing materials, including thick stacks of newspapers, wood, or even steel plates. This practice should be avoided, for the bullet interacts differently with the armor when backed with these materials than with the clay-backing material. Furthermore, other backing materials can be unsafe. In several cases, bullets have bounced back and injured the officer shooting at the armor.

V₅₀ Testing

V₅₀ ballistic limit testing is a statistical test developed by the U.S. military to evaluate hard armor of homogenous construction used to protect vehicles. Many body armor manufacturers use a modified form of the military V₅₀ testing as a design tool to develop and assess new body armor designs. V₅₀ testing as used by body armor manufacturers experimentally identifies a velocity at which a specific projectile has a 50-percent chance of penetrating the armor being tested.

In this form of testing, the armor is mounted on the clay-backing material, and specified bullets are fired to determine the velocities at which the bullets do and do not penetrate the armor. A sufficient number of bullets are fired at various velocities to obtain groups of five nonpenetrating bullets and five penetrating bullets, with a velocity range of no more than 38 m/s (125 ft/s) between the lowest velocity nonpenetrating bullet and the highest velocity penetrating bullet. The V₅₀ ballistic limit is calculated as the average velocity of the 10 bullets.

V₅₀ ballistic limit testing allows manufacturers to evaluate various designs against one another to optimize their design for a specific type of body armor. A trend has emerged in which manufacturers publish V₅₀ test data and also put V₅₀ test information on the labels of some of their body armor.

V₅₀ ballistic limit testing is a useful and informative statistical tool for evaluating certain characteristics of armor. In addition to being helpful during the design phase of armor development,

it may also have the potential for being a valuable tool in evaluating armor's degradation over time. However, it does not evaluate the level of protection afforded against blunt trauma, nor is a uniform standard for V_{50} ballistic limit testing used by all manufacturers.

Ballistic Limit Testing

As part of NIJ Standard–0101.04, the Office of Law Enforcement Standards (OLES) has developed a performance assurance program to determine the ongoing performance of body armor currently in service or a new production unit of a previously tested and approved model. The Baseline Ballistic Limit test will establish a benchmark of penetration performance and will provide a reliable and consistent way to retest NIJ-compliant armor. The ballistic limit test does not have a pass or fail performance requirement; it provides additional information about the ballistic performance of a given armor model. The ballistic limit testing is done after the armor model has successfully passed the traditional penetration and backface signature testing. The performance assurance program is based on V_{50} testing.

All ballistic-resistant materials can ultimately be overmatched whether by bigger or faster bullets or simply by firing the same bullet fast enough to eventually overcome the ability of the given material to stop it.

The V_{50} ballistic limit, within statistical reason, identifies the velocity at which the armor material stops the bullet at least half the time. Knowing that the ballistic limit of a particular body armor model is well in excess of the NIJ reference velocity—at which no penetration is expected or allowed for in compliance testing—provides additional assurance of the overall ballistic performance of the armor even in instances where the encountered threat may be beyond the expected norm.

Acceptance and In-Service Testing

Acceptance testing should be performed whenever a large-quantity purchase is received. However, NIJ does not consider this guiding rule to apply to blanket purchase agreements and term contracts, because manufacturers may produce individual purchase orders from several lots of material. In these cases, a department may want to carry out limited testing periodically, but, to test armor from each production lot would be expensive and impractical. Again, the manufacturer and the purchaser must address in the contract what will happen if any of the armor fails to comply with NIJ Standard–0101.04. For instance, the manufacturer might agree to replace any armor manufactured from the lot of ballistic material that failed testing. In addition, a department may want to test previously purchased armor that was manufactured from material lots not included in prior screening tests. To accurately assess its testing alternatives, a department must consider the structure of its blanket purchase agreement or term contract.

A department can accurately estimate testing costs only if it knows how many tests will need to be conducted. Thus, a department that requires acceptance testing—especially for small-quantity purchases—may want to include in its contract a clause limiting the number of ballistic material lots that will be used to manufacture the armor to a few lots or even one. Testing costs are either directly paid by the department or absorbed into the manufacturer’s unit cost. Indirect costs associated with acceptance testing and later service-life testing include administrative paperwork; time for analyzing the results; and travel, if the department wants a representative to witness the ballistic testing.

Police departments often include armor testing costs and departmental travel as manufacturer-related expenses, which are part of the bid price. However, NIJ does not recommend this practice because the public served by a department might doubt the propriety of an officer who accepts travel expenses from the manufacturer when the performance of armor purchased is in question. Instead, NIJ suggests that the department separately budget for armor testing and contract directly with a National Law Enforcement and Corrections Technology Center (NLECTC)-approved laboratory. This provides a clearer picture of the armor purchase price per unit and provides the department with more flexibility in its testing program.

Finally, a department that elects to conduct acceptance or service-life testing must remember to order an adequate number of additional sets of armor to be used for testing. For more information on service life, or life cycle testing, please see the discussion on this topic in chapter 10 (page 60).

7. Stab-Resistant Personal Body Armor

Armor Classifications for Stab-Resistant Armor

The first step in selecting the appropriate protection level of stab-resistant body armor is to establish the level of protection that users need based on the realistic weapon threat they face.

NIJ Standard–0115.00 places stab-resistant body armor into two categories based on the kind of threat it is designed to stop. One category of protection, designated the “edged blade” class, stops engineered or high-quality blades, such as kitchen knives or those purchased at sporting goods stores, and represents the threat more commonly found on the street. The second category, the “spike” class, stops the types of improvised weapons commonly found in correctional facilities, typically made of lower quality materials that may have been sharpened on concrete or other rough surfaces.

Within each of these two categories are three levels of protection, based on the energy that would impact the body armor during an attack. The amount of energy expended in an attack is expressed in joules. One joule is equivalent to 1 foot-pound of energy or the amount of energy delivered from a 1-pound weight dropped from a height of 1 foot.

Level 1 is a low-level protection armor suitable for extended wear, generally concealable, and capable of defeating 24 joules of energy. Level 2 armor is a general duty garment suitable for extended wear that may be concealable or worn over the uniform that will defeat 33 joules of energy. Level 3 is a high-level protection armor suitable for wear in high-risk situations that will defeat 43 joules of energy. As an example, a prison administrator might wear 24-joule body armor in the spike category, designed to stop improvised weapons, while a corrections officer on a high-security unit would wear the spike category, level 3, 43-joule body armor.

As stated in chapter 5, in developing the standard, NIJ relied on the extensive research experience of the Police Scientific Development Branch (PSDB) in the United Kingdom (UK), where the primary threat to law enforcement officers is from sharp-edged and pointed weapons. As part of their initial research, PSDB created a model to determine the actual forces generated by an assailant during attack, and, from this model, developed realistic test methodologies and procedures that could be replicated in the laboratory. Several different types of blades were engineered to accurately reflect actual threats faced by law enforcement and correctional officers. Although these blades are specially designed to ensure consistency in testing procedures, they reflect many of the features found in the high-grade commercial knives or homemade instruments most commonly used in attacks.

The threats from ice picks and lower quality, prison-made knives and shivs are much more difficult to quantify than those from commercial knives. Research addressing homemade instruments continues, and any improvements from this research will be incorporated into future revisions of NIJ Standard–0115.00. For the present time, the same test methodology will be used

for homemade weapons as is used for commercial knives, but the threat weapon is a modified ice pick commonly used in the “California Ice Pick” test.

Developing the Testing Procedure

Before PSDB could develop equipment to test body armor under conditions that could be replicated in the laboratory, researchers examined the mechanics of stabbing, first reviewing medical data from more than 1,000 actual stabbing assaults in the UK. Using this information, they developed an instrumented blade, or “stabometer,” that could measure the acceleration and force generated by a stabbing impact. Five hundred healthy male recruits used the stabometer, stabbing from a variety of directions and using a number of techniques such as a jab, roundhouse, overhead, and double- and single-handed stab. Measurements taken from these tests documented the energy of a stabbing incident. A second series of tests examined other factors that affect the stabbing act—technique, strength, attitude, coordination, and body position.

From this data, PSDB created a testing mechanism, the dual-mass drop system that accurately replicates the mechanical forces that would impact the body armor during an attack. For the highest level of protection, a vest should be able to withstand 43 joules of energy, allowing no more than 7 millimeters ($\frac{1}{4}$ inch) of penetration.

During the testing procedure, the body armor is placed on backing material designed to most accurately replicate the response of the human torso during a stabbing incident. The backing material is a composite consisting of alternating layers of closed-cell foam and neoprene rubber. To test nonflexible armor designs molded to the shape of the human torso, an alternate backing of modeling clay is used.

Overtest

As part of the testing procedure, an overtest is performed for each level of protection. The test protocol increases the kinetic energy of the knife blade or spike by 50 percent to ensure that there is an adequate margin of safety in the armor design. At the higher energy condition, a maximum blade or spike penetration of 20mm (.79 inch) is allowable.

8. Armor Selection

Armor Styles

Concealable body armor. The most widely used type of body armor is the protective undergarment, which is worn under the normal uniform shirt. If properly designed, these garments are relatively comfortable, lightweight, are not unduly restrictive of movement, and are available in a variety of designs.

Typical male and female undergarment body armor garments are designed to provide full front, side, and rear protection. Most undergarment armor uses a hook-and-pile tape fastening system; some older models may feature a “D” ring-fastening system. The ballistic panel is often contained in pouches in a polyester/cotton carrier. When purchasing undergarments of this type, two carriers should be ordered to permit one to be laundered while the other is worn. Metal fasteners should be avoided, for they can become secondary missiles. Hook-and-pile tape fasteners, such as those manufactured by Velcro Corp., should be at least 1½ inches wide and should provide approximately 2 inches of adjustment. In addition, the fasteners should be anchored to a good-quality elastic, approximately 3 inches long, to facilitate proper adjustment and to compensate for body movement.

The concealed undergarments for female officers should conform to the female anatomy. The seam construction for such garments that include seams is critical. It is very important that the joined pieces overlap each other a minimum of 1 inch. Particular attention should be paid to the length of the garment, which is a frequent problem. The adjustment straps for the female undergarment may be fastened to the back to improve the overall appearance of the uniform.

Many manufacturers market loose-weave undershirts to be worn with body armor. These undershirts may appear to improve airflow over the armor, minimizing heat build-up and perspiration.

Protective undergarments are also available with special pouches that allow additional ballistic protection by inserting armor panels, commonly known as “trauma packs,” in the front and in some cases, the rear. These panels may be hard, composed of metal, ceramic, or rigid plastic, or may be soft, made from additional layers of typical vest materials. Note that the increased protection applies only to the portion of the torso behind the insert. Thus far, the National Institute of Justice (NIJ) has not conducted research to determine the effectiveness of such inserts. In general, NIJ believes that agencies should select armor that provides the rated level of protection over the entire area of coverage, not just isolated areas.

Materials used to construct concealable body armor also permit the design of various other armor configurations, which are sometimes used by police officers assigned to nonuniform duty, such as detective or security details. These include the ballistic-protective sports coats and vests. In addition, raincoats and a variety of jackets, all with ballistic liners, are available. Officers can even purchase shirts with ballistic protection. Even more casual appearing protective vests, such

as a simulated down outer vest and a denim work jacket, are on the market. Numerous designs of tactical protective vests are also available. All these styles of body armor can meet the requirements for the NIJ standards.

Semirigid body armor. Body armor that provides protection against higher threat levels (III and IV), as specified in NIJ Standard–0101.04, will be of either semirigid or rigid construction. Semirigid armor can consist of a somewhat flexible material with impregnated ballistic fabrics or a garment composed of small articulated plates of ballistic material such as steel, ceramic, or plastic, reinforced with some type of woven ballistic material. This design borrows from the naturally occurring armor design of the armadillo. Semirigid vests are difficult to conceal and allow the use of dense materials (high areal density), while retaining limited movement.

Rigid body armor. Rigid body armor is composed of molded ballistic material, designed to cover certain portions of the body. Rigid body armor is perhaps the most restrictive of body movement and is also difficult to conceal. A typical tactical vest incorporates a panel of rigid armor into a typical concealable armor vest and is worn externally. In general, semirigid and rigid body armors are used only for short periods when expecting confrontation with high-level threats. Users should carefully review the labels of rigid armor to determine if it offers single-shot or multihit capability.

Comfort and Fit

When selecting armor for full-time routine use by an officer, comfort is a major factor. Armor that is set aside or relegated to the trunk of a cruiser is of no benefit. The NIJ development effort recognized this “real world” problem and therefore emphasized comfort in the design of lightweight body armor for police use. Two fundamental factors were considered: fit—from the standpoint of mobility and the weight distribution of the armor—and heat discomfort. Both armor characteristics were evaluated by the U.S. Army Natick R&D Command using instrumented anatomical models of the human body. The weight-distribution measurements led to an improved design for the garments. Similarly, the dissipation of body heat through body armor was measured. Those tests demonstrated that, during normal activities, an individual wearing body armor would not suffer unduly from reduced dissipation of body heat. For example, the long-sleeved police uniform has roughly the same heat dissipation as utility army fatigues. Adding the original NIJ vest to the police uniform prevented about the same amount of heat loss as adding a liner to an army fatigue helmet.

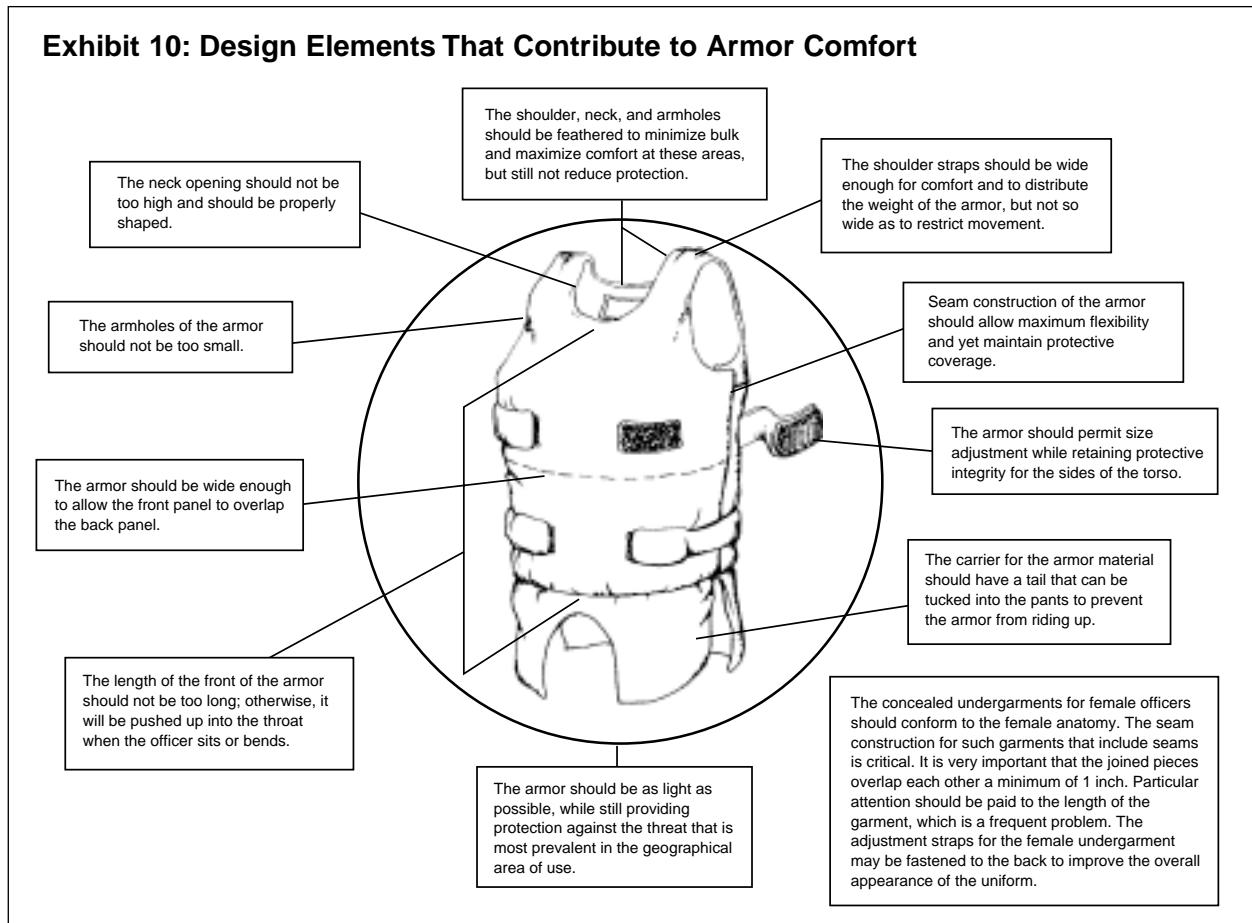
Comfort, with respect either to fit or to heat dissipation, is at best subjective and a matter of individual sensation. However, adequate case history and field experience exist to indicate that body armor is suitable for full-time use and that an officer should accept minor discomfort in exchange for the protection that is afforded. To resolve questions concerning comfort, a few members of the department might wear samples of armor on a trial basis before the department makes a major purchase.

SELECTION AND APPLICATION GUIDE TO PERSONAL BODY ARMOR

The introduction of several new fabrics used to make the permanent protective cover for the ballistic- or stab-resistant element and the removable outershell carrier have greatly enhanced the comfort and wearability of body armor. GoreTex®, a fabric made of expanded Teflon®, is a water-resistant fabric that, according to the manufacturer, allows perspiration to evaporate but prevents moisture from reaching the ballistic material. By using GoreTex®, some manufacturers have eliminated the water-repellent treatment on the ballistic material, which they claim improves the “breathability” of the vest.

CoolMax®, a fabric originally developed for use in athletic apparel, is now being used by some manufacturers in place of traditional cotton and nylon fabric in manufacturing the removable outershell carrier of the vest. According to the manufacturer, CoolMax® acts like a wick, drawing perspiration away from the body to the outer surface of the garment, where it can more easily evaporate.

Laboratory tests and comments from officers who wear body armor during their daily shifts have identified a number of factors that bear on the comfort of body armor when worn for extended periods of time. See exhibit 10 for a listing of factors to consider when evaluating armor.



Coverage

It is possible to purchase armor that covers only the front torso, with a separate section that can be added to protect the rear torso and the sides. An officer who spends nearly the entire duty shift in a vehicle may be tempted to wear only chest protection, but this is not advisable.

Statistics bear grim testimony to the importance of using armor that provides full coverage. According to the UCR data from the period 1990 to 1999, 290 law enforcement officers were killed while wearing protective armor (see exhibit 11). Of those officers 160 (55.2 percent) were killed by gunshot wounds to the head; 101 (34.8 percent) died as a result of gunshot wounds to the upper torso; 18 (6.2 percent) died as a result of gunshot wounds below the waist; 5 (1.7 percent) were struck by automobiles; 2 (0.7 percent) were stabbed; and 4 (1.4 percent) died by other means.

Of the 101 officers killed by gunshot wounds to the upper torso, 40 (39.6 percent) were killed when the round entered the torso region between the panels of the vest or through the arm openings, and 34 (33.7 percent) were killed when the round landed above the coverage area of the vest (see exhibit 12). Therefore, a vest must provide full front, side, and back protection with the wrap-around portion going from front to back. Proper fit is equally important for ensuring adequate coverage and protection. Ideally, officers should be individually measured and fitted for concealable body armor. Because a large weight gain or loss can have an adverse impact on proper fit, armor should also be inspected routinely to ensure proper fit. Improperly fitting armor needs to be brought to a supervisor's attention immediately for corrective action.

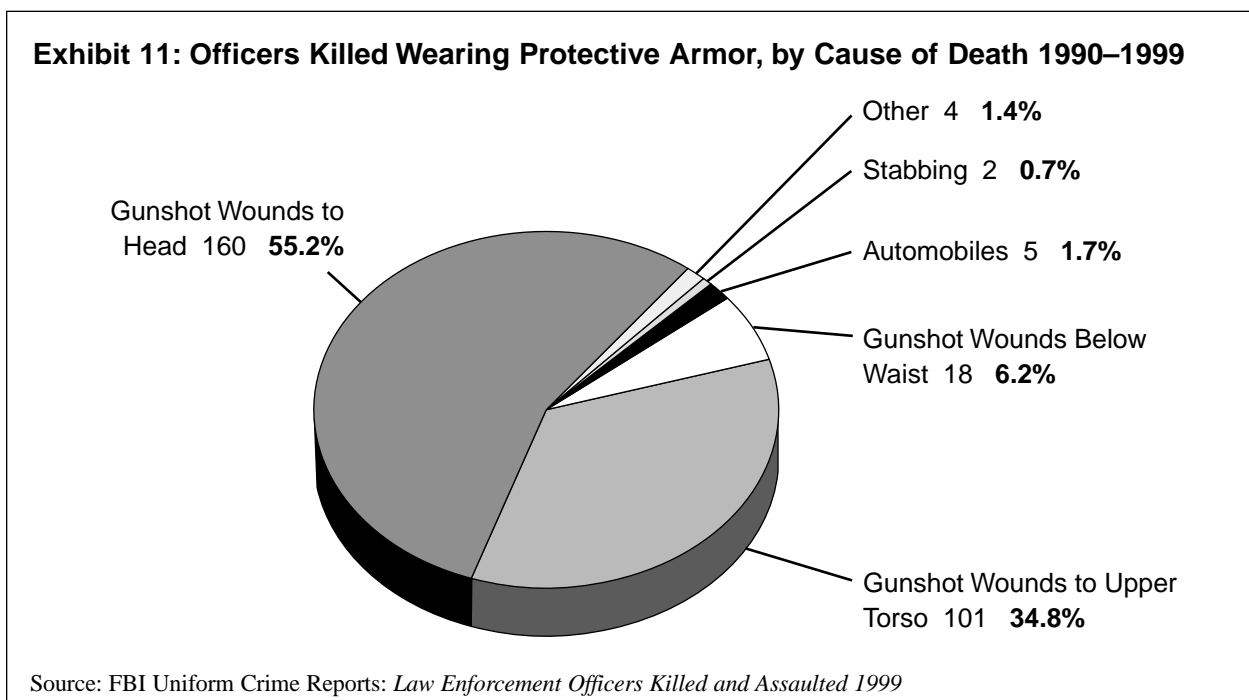
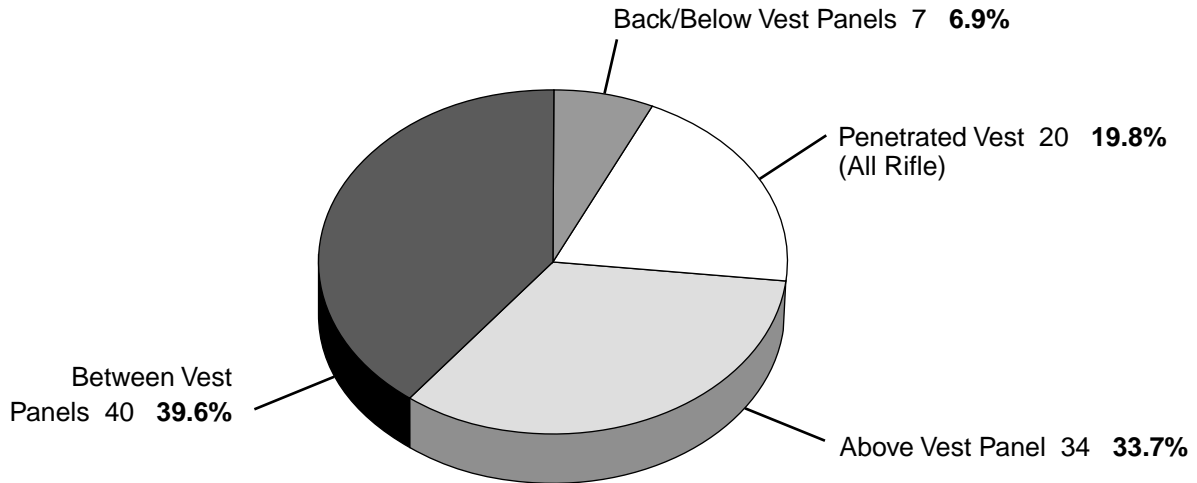


Exhibit 12: Upper Torso Deaths, by Location of Rounds 1990–1999



Source: FBI Uniform Crime Reports: *Law Enforcement Officers Killed and Assaulted 1999*

Twenty of the 101 officers killed by gunshot wounds to the upper torso died as a result of rounds penetrating the body armor. Of these 20 incidents, all were the reported result of rifle rounds, which the armor was not designed to protect against. **It is important to note that no documented fatal injury has ever resulted from a round of ammunition penetrating body armor that NIJ had approved as protection against that level of threat.**

9. Purchasing Body Armor

Overview

Before purchasing body armor, an agency must first assess its potential threats and determine what level of protection is required for its officers. Only after determining the protection needs of the department should those responsible for purchasing body armor begin to review specific products. Next, the department should select several models, preferably from several different manufacturers, from the *Personal Body Armor Consumer Product List (CPL)* that meet the department's protection needs. This document, published electronically on the National Law Enforcement and Corrections Technology Center (NLECTC) JUSTNET Web site, provides a listing of the armor models that have been tested and found to comply with National Institute of Justice (NIJ) standards, which independently validate the manufacturer's claims regarding the performance characteristics of the vest.

The next step is to solicit competitive bids from the companies or company representatives that manufacture these models and to choose a model, usually the most cost-effective option. When the armor arrives, the purchaser should verify that the armor received is the specific model that was ordered.

Criminal justice agencies can buy ballistic- and stab-resistant body armor for half the price by taking advantage of the U.S. Department of Justice's Bulletproof Vest Partnership (BVP) Grant Act of 1998, administered by the Bureau of Justice Assistance (BJA). The chief executive officer of a law enforcement agency can apply online to purchase NIJ-approved vests. (Go to <http://vests.ojp.gov/leas.html> to learn more about how the chief executive officer is defined and to learn more about the application process.) BJA will match up to 50 percent of the cost of the armor, including the cost of shipping and taxes. The Bulletproof Vest Partnership Program was enacted to save the lives of law enforcement officers by helping States and local and tribal governments equip their officers with body armor.

Congress appropriated \$25 million for the program's second year. At least half the funds are provided to local government units with fewer than 100,000 residents. The Bulletproof Vest Partnership Grant Act of 2000 was recently enacted. This means the program will remain in effect for 3 more years, from 2002 to 2004. It also provides priority funding for jurisdictions with populations under 100,000 and increases the authorized funding level to \$50 million each year. These changes will not take effect until 2002. The applications accepted in 2001 will be governed by the current BVP Act of 1998.

At a glance, purchasing body armor may seem like a relatively simple process. However, complications sometimes arise from various sources that make the purchasing process much more involved. Two of the principal problems that can complicate the purchasing process are obtaining objective information from salespeople and the tendency to overspecify departmental needs through the departmental procurement process.

A salesperson's goal is to persuade a department that his or her product is the best available. Sometimes, a salesperson will suggest a department include requirements unique to his or her company's product in purchase specifications. Also, some manufacturers use product demonstrations that are designed to show that their armor is superior to that of competitors. Departments should be cautious of these practices. Basing purchasing decisions on NIJ standards and the *Personal Body Armor CPL* can help departments avoid the problems caused by the use of a single manufacturer's construction and/or design specifications. These problems include paying higher rates if the specifications limit competition to a single source or purchasing armor that may not meet department needs.

Police departments often handle armor procurement as a committee action. This approach can result in overspecification of department needs, caused by trying to satisfy all of the committee members by including each member's personal preferences in the product specifications. A more efficient approach is to assign the task to two or three officers, provide resources to help them familiarize themselves with armor technology, and allow them to independently assess the department's needs. The officers should then make a decision, informing the department's administration, justifying their selection, and being prepared to demonstrate why their choice represents the needs of the majority of officers.

The Procurement Process

Typically in the procurement process, an agency or department develops requirements, solicits bids, reviews bids and submitted samples, and then awards the contract to the bidder that best meets the price and product specifications.

Generally, armor purchases fall into one of four categories:

- Individual purchases from a distributor or retail outlet.
- Small-quantity departmental purchases.
- Large-quantity departmental purchases (several hundred units or more).
- As-needed purchases procured through an open-ended agreement (also called a term contract).

Individual or small-quantity purchases can be best described as “what you see is what you get.” Large-quantity purchases should be made only through a competitive process involving several bids from the manufacturers that produce the models meeting the department's protective needs.

The NIJ standards focus on the protection characteristics of body armor, and the *Personal Body Armor CPL* presents the models that meet the requirements of the standards. Departments that base their purchases on the *Personal Body Armor CPL* need to specify in the purchase agreement any additional features they require, as determined during the needs assessment phase, such as color or area of coverage.

Procurement of law enforcement equipment should always focus on the following areas:

- Clarity. Ensure that the purchase agreement is not ambiguous in any way.
- Simplicity. Include only items essential to the purchase agreement.
- Internal consistency. Ensure that requirements for each individual item do not conflict with one another.

To ensure that bids involve only armor in compliance with NIJ Standard–0101.04 or NIJ Standard–0115.00, a typical purchase agreement might include the following wording:

The body armor model shall be tested by NLECTC and found to comply with all requirements of NIJ Standard–0101.04 (or NIJ Standard–0115.00). It shall be of Type (specify appropriate threat level and test ammunitions) as defined in that standard, and shall afford full protection to the torso front, torso back, and sides.

A purchaser needing special ballistic protection that would require additional testing should specify the exact test rounds to be used (listing such variables as caliber, bullet shape, bullet mass, configuration, and velocity) and state that NIJ Standard–0101.04 (or NIJ Standard–0115.00) will govern in other respects. When additional testing is needed, the police department should place reasonable time demands on the manufacturers.

A department developing a purchase agreement should be aware of two issues that may complicate the procurement process. The first, mentioned earlier in this chapter, is to describe a particular product in the product specifications section of the solicitation for bids, which would eliminate the chance of a truly competitive process. Instead, the department should consider requesting bids for armor that complies with NIJ standards and then add specific, nonprotective features only if essential. The second issue is the requirement that the department accept the lowest bid. Instead, the department should consider adding a clause in the bid solicitation that allows the agency to buy from the manufacturer offering the armor that best meets the department’s needs and that the officers find most comfortable.

Ensuring Compliance Status

Just as a department should not purchase a model of armor that has not been tested by NLECTC or does not comply with NIJ standards, a department also should not accept statements—written in the bid or verbally made by a salesperson—that the model shown is “just like” or “identical to” a model from the *Personal Body Armor CPL*. Instead, those responsible for procurement should ensure that the armor model designation on the ballistic panel label is identical to the one listed in the *Personal Body Armor CPL* and should receive proof (a copy of the compliance letter issued by NLECTC to the manufacturer for that model) that the armor is in compliance with NIJ standards. If the supplier or bidder cannot provide these two items, the department

should use another supplier. If a department still has questions about the compliance status of a particular model, they should contact NLECTC at 800-248-2742 or 301-519-5060.

Model Procurement Specifications

Major purchases of armor give departments the chance to specify exactly what features they want included in the product design that will provide for officers' body armor needs. Also, each jurisdiction is subject to departmental procurement terms and must add specifications to the solicitation and purchase agreement as required by these terms. For instance, Federal procurements often include a clause requiring that the items purchased be manufactured in the United States; other jurisdictions may require that preference be given to small businesses or local manufacturers. Such contract conditions are often written in wording standard to all departmental purchasing orders and then inserted in appropriate sections of each bid package. Yet, departments should remember that overspecification can complicate the procurement process by making it difficult for a department to find a product that meets all of the specifications.

Documents related to the procurement of body armor should include certain items. The issues discussed in the remainder of this chapter apply to the specifications section of purchase orders and assume that the department has previously assessed its officers' protection needs and determined the appropriate type of armor, as specified in NIJ Standard-0101.04 and/or NIJ Standard 0115.00. Departments should not include requirements that are unreasonable or technically impossible to achieve.

The following guide to procurement specifications assumes the department has selected a specific type of armor from a single manufacturer that provides the needed protection level. (Appendix D provides an example of the procurement specifications section of a purchase agreement solicitation.) Negotiating an open-ended agreement (term contract) for multiple models, styles, and armor types from a single manufacturer involves a separate set of issues.

Terms of agreement. Whether a department purchases armor in a single quantity (buying one unit at a time or a quantity at one time), through a blanket purchase agreement, or under a term contract, the bidder must know how many units will be purchased, including the number of vests for female officers. Under a blanket purchase agreement, an agency can purchase units "as needed" during the life of the contract. No matter which approach is used, a department may want to include a clause for ordering additional units, which would make future purchases simpler because new bids would not be required.

Prebid conference. When purchasing a large quantity of armor or considering a blanket purchase agreement, a department may want to arrange a prebid conference between it and prospective bidders. Bidders and the department can then review the solicitation as well as the department's specifications, so that all parties clearly understand the department's needs. Also, a prebid conference may reveal any ambiguous or contradictory terms or requirements in the solicitation. If the solicitation needs to be modified, the department can issue an addendum.

Bidding and award process. The clauses in procurement packages should be self-explanatory and furnish adequate flexibility in purchasing the armor considered most appropriate for the department. Again, the *Personal Body Armor CPL* should be the main resource for departments. In the bid, the manufacturer should identify the specific model it proposes to provide. Moreover, the final purchase agreement, if other than the bid solicitation package, must specify the model selected.

Invoicing and delivery. This section of the package should propose a detailed delivery schedule and should specify departmental invoicing and payment regulations and procedures.

Warranty and insurance. These clauses clarify the warranty on the purchased units. Here the department must specify the amount of product liability insurance required based on its needs or on the options available from the manufacturer. Product liability insurance can be expensive; a department should consult with counsel about liability insurance's benefits to the department before including an insurance clause.

Armor specifications. This section is the focal point of a procurement program, because here the department delineates the protection performance it expects of the armor to be purchased as well as departmental preferences about design and configuration. (See appendix D.)

Item A—Compliance with NIJ standards. Citing the ballistic performance required by specifying the appropriate armor type, as defined by NIJ Standard–0101.04, or the stab-performance requirements of NIJ Standard–0115.00, is a mandatory component of the specifications section. This information ensures that the armor ordered provides a known performance level.

Item B—Labeling. The label included on the protective panel is another critical item, as it alerts the wearer to how limited the protection provided is. It also states that the individual unit complies with NIJ Standard–0101.04 or NIJ Standard–0115.00. If the unit does not perform as stated on the label, a department may have the right to legal recourse.

Inclusion of the manufacturer's model number on the protective panel label is also important because it is the primary means for verifying that the armor received is that ordered and that the compliance matches the armor type listed on the purchase order. In past cases reviewed by NLECTC, armor has been labeled differently (i.e., providing a lower level of protection than that ordered) than what the purchase agreement has specified.

A manufacturer or distributor may use catalog numbers or similar designations to further identify the product if the armor is properly identified as a specific model in compliance with either NIJ Standard–0101.04 or NIJ Standard–0115.00. The catalog number must be separate from the model or style number. Meanwhile, the model number should be unique and the same as the model number tested by NLECTC.

Again, it is important that departments purchase only models that have been tested by NLECTC and found to comply with either NIJ Standard–0101.04 or NIJ Standard–0115.00. By doing so, if there ever is any question about an individual unit's configuration or construction, the armor

can be compared with the unit of that particular model that was originally tested by NLECTC, which NLECTC retains in archival storage.

Item C—Configuration. Specifying a particular configuration of protective panel in a particular carrier is essential if the department believes that only one type of configuration will meet the department’s needs. A department that wants to explore its configuration options may not want to include such a statement.

Manufacturers sometimes use protective panels that were tested and found to comply with NIJ Standard–0101.04 or NIJ Standard–0115.00 in more than one configuration. For instance, a protective panel may have been tested in a configuration with an open, unprotected area on the side of the torso; an identical protective panel may also be manufactured with the sides extended to create an overlapping configuration. These two are considered to be the same model.

Item D—Adjustment options. This clause identifies design features that will make the armor more comfortable for the wearer. However, this clause may not apply to tactical armor or other armor configurations worn outside of clothing.

Item E—“Riding up.” Wearing armor for long periods of time can cause the armor to move up on the wearer’s body, which decreases the officer’s comfort. This clause applies only to concealable armor and may not be necessary if the adjustments in Item D are completed.

Item F—Metals. Departments should carefully evaluate purchasing armor that includes any metal components, as the wearer may be injured if a bullet strikes the metal part and ricochets, or if a piece of the metal component breaks off and becomes a secondary projectile.

Item G—Color. To ensure that the armor is properly concealed, it is important for departments to choose a color that will not be visible through the wearer’s uniform.

Item H—Quality. This clause ensures that the manufacturer will produce the armor using suitable materials and high workmanship quality.

Departments should not include any specifications that are unique to one manufacturer’s product so as not to reduce their available options to a single model. Likewise, they should not try to dictate how the protective panel used in the armor is constructed. For instance, a department should never specify a specific fabric or weave for the ballistic- or stab-resistant material, nor should it specify the number of layers of material to be used. Doing so could restrict the bid to a single manufacturer, result in armor that does not meet the requirements of NIJ Standard–0101.04 or NIJ Standard–0115.00, or create conflicting requirements, in which case the manufacturer could be released from liability if the armor does not perform properly. In addition, departments should not name a maximum weight, which could mean that officers would not receive the needed ballistic- or stab-resistant protection because the required type of armor weighed more than the specified limit.

Departments should also include in the procurement specifications any features identified as essential in the needs assessment phase. For instance, some departments have required that armor be designed so that the front and back panels cannot be worn separately, to prevent officers from wearing only the front part of the armor. Other departments require that concealable armor be supplied with two carriers, so that one can be laundered while the other is in use. Regarding armor configuration, NIJ recommends that armor provide side protection for full torso coverage. Overlapping the front and back panels by at least 1 inch—preferably 2 inches—will accomplish this. NIJ suggests that when overlapping the two panels, the front panel should overlap the back panel to prevent a round from “skipping” between the two panels.

If the department wants each officer’s armor to be custom fitted, the specifications section should include a clause to that effect, stating how and where fittings will take place. Also, labeling specifications should require that a space be included on the label where the name of the officer can be printed on the armor label by the purchasing agency.

A number of other items can be included in the procurement specifications, such as requiring that the armor use nonmetallic “D” rings or hook-and-pile fasteners, but NIJ does not recommend this practice. Items of personal preference are best addressed when departments are inspecting the manufacturers’ samples and evaluating them for comfort. In addition, prospective buyers should remember that specifying a number of required design characteristics increases the chance that the armor will become a custom or nonstandard design, which could require additional testing to ensure compliance with NIJ standards.

Items to be submitted with the bid. This section—a listing of the required items to be included in the bid package—should be self-explanatory to bidders. Because each department is subject to a particular set of procurement regulations, additional clauses addressing these requirements will most likely be necessary.

Termination of agreement. A clause that specifies the conditions under which the department can terminate the contract must be included in any procurement documents. If a department is purchasing through a blanket agreement or term contract, it may want to include a “for the convenience of the department” 30-day, written-notice clause allowing the department to cancel the agreement if officers find the armor received to be unacceptable—even though in full compliance with the procurement specifications.

Another justifiable reason for breaking the contract is if the armor is not delivered according to the predetermined shipping schedule, in which case the department should be allowed to cancel the contract and begin legal proceedings for default. Receiving a substandard product should also justify canceling the contract. When listing the product specifications, a department must be sure to define the reasons why the product may be rejected and the contract terminated. For instance, poor workmanship is a legitimate cause for rejection, but may be difficult to objectively establish unless previously defined in the purchase agreement.

Protection/Testing Considerations

Although body armor for routine, full-time wear has been available for approximately 25 years, the state-of-the-art technology continues to change. For instance, manufacturers once used almost exclusively a single type of fabric in constructing concealable body armor. Today, at least five different types of fiber are used to manufacture ballistic-resistant fabric, each of which is available in a variety of woven and nonwoven fabrics and panels. The ballistic protection properties differ among materials and often two or more types of fabrics or composites are used in combination to manufacture a vest. Because of these complexities, a department should not attempt to dictate how the ballistic element will be constructed, such as by specifying the number or types of layers of ballistic material. Armor performance is the critical issue, not the manufacturer's construction of the armor.

Many of these concepts are also true for stab-resistant armor, which has emerged as a viable option for corrections officers over the past several years. Advances in materials technology has allowed body armor manufacturers to design stab-resistant vests that are considerably lighter, more flexible, and wearable than models previously available, which were extremely bulky and frequently contained layers of metal or chain-mail type material.

10. Maintaining Body Armor

The proper care of today's modern body armor requires taking precautions when cleaning the garment. Every model of armor that complies with NIJ standards has an instruction label indicating how to clean the components. Individuals should follow these instructions, making certain that anyone else who cares for the garment is also aware of the correct cleaning procedures.

The protective panels, or inserts, of body armor should be washed by hand with cold water, using a sponge or soft cloth and mild home laundry detergent. Most manufacturers strongly recommend that the protective panel never be submerged in water. Bleach (including nonchlorine or peroxide-based bleach) or starch, even when highly diluted, should not be used as these may reduce the garment's level of protection. If a model of armor has a removable carrier, it is possible that the carrier may be machine washable. However, it is imperative to follow the manufacturer's care instructions found on the protective panel and carrier labels.

Body armor panels or inserts are not to be machine washed or dried, either in the home or commercially. The fabric can be damaged by laundry equipment, ultimately affecting its performance. Commercial laundries also use commercial detergents, which are much harsher than home detergents, and pose another threat to maintaining the ballistic- or stab-resistant properties of the fabric. According to DuPont, perchlorethylene is the only drycleaning solvent found so far that does not significantly degrade the ballistic protection provided by current body armor.²¹ However, to eliminate the possibility of an accident and avoid the variety of drycleaning solvents in use, drycleaning armor is not recommended.

Most modern body armor contains water-repellant treated or inherently water-repellant fabrics, making hand washing possible by preventing the water used to wash the vest from degrading the ballistic capabilities of the vest. However, rinsing thoroughly is still important to remove all traces of soap. Rinsing properly prohibits the accumulation of residual soap film, which can absorb water and reduce the protective properties of certain types of ballistic- or stab-resistant fabric.

Body armor fabric should never be dried outdoors, even in the shade, as ultraviolet light is known to cause degradation of certain types of ballistic fabric. Tests have demonstrated that ballistic efficiency is significantly and adversely affected by exposure to sunlight for extended periods of time.

Each time body armor is washed, it should be inspected for any signs of wear. If the protective materials are not covered with a permanent cover (which is highly uncommon for a typical modern vest), and it appears that the thread used to sew layers together is wearing badly or that the fabric is unraveling, the vest should be returned to the manufacturer for replacement. Officers should never attempt to repair armor themselves under any circumstances.

Today, most manufacturers market concealable body armor with the protective panel sealed within a moisture barrier, such as thin rip-stop nylon or coated cloth, instead of chemically

waterproofing the fabric. The owner of such armor must routinely inspect it to be sure that the cover of the protective inserts has not been cut or damaged, which would allow moisture to penetrate the protective panel. Even if the outer covers have not been cut or otherwise damaged, the moisture barrier can still be damaged. When the protective material or the outershell carrier rubs over the protective panel cover as a result of the normal flexing that occurs when body armor is in use, it can wear through the cover and expose the armor to moisture penetration. It should also be noted that certain types of covering materials tend to make the armor much warmer to wear, because it significantly reduces the rate at which perspiration can evaporate or be absorbed.

The exceptional ballistic- and stab-resistant efficiency of materials used to construct body armor compensates for any of these limitations associated with maintenance and care. The user can easily care for and properly maintain body armor and ensure that it provides its rated protection throughout its service life.

When caring for hard armor, it is important to remember that hard body armor, particularly ceramic material, must be handled carefully because it is fragile. Ceramic materials—such as boron carbide, aluminum oxide, or silicon carbide—are extremely brittle. Such armor should not be dropped on hard surfaces and when used, the ceramic must serve as the striking (exterior) surface. It should also be inspected before each use to ensure that no surface cracks are present that would degrade ballistic performance.

Body Armor Life Expectancy

One of the most frequently asked questions the National Law Enforcement and Corrections Technology Center (NLECTC) receives is, “How long does body armor last?” Unfortunately, no definitive answer can be given to this question. Every piece of armor will eventually have to be replaced. Body armor is not a one-time buy. For example, if a department changes its service weapons or ammunition, the armor worn by its officers must be shown to protect against the new weapons systems. The armor must be capable of defeating typical ammunition threats that the officers may face (see chapter 6). If an agency determines that the ammunition threats that they face have increased, upgrading to a higher level of protection may be appropriate. An individual’s body weight may change over time, and armor that no longer fits or is uncomfortable is likely not to be worn.

Since no two pieces of armor are exposed to identical wear or care, each must be evaluated individually. Armor can generally be classified according to its appearance: “New,” “Good,” “Fair,” or “Poor.” Currently, the only method to evaluate armor’s performance is destructive ballistic testing. The National Institute of Justice (NIJ), through its NLECTC system, is investigating development of alternative methods to evaluate body armor’s ongoing performance and lifespan. The first step in this process is the introduction of the Baseline Ballistic Limit Test in NIJ Standard–0101.04. See page 41 for further discussion of this test.

Age alone does not cause body armor's ballistic resistance to deteriorate. The care and maintenance of a garment—or the lack thereof—have been shown to have a greater impact than age on the length of service life of a unit of body armor. Armor that is 10 years old and has never been issued may be perfectly acceptable for use, provided that the rated level of protection is still appropriate for the typical threats faced. Conversely, 2- or 3-year-old armor that has been worn regularly and improperly cared for may not be serviceable.

Limited studies of the ballistic-resistant capabilities of armor used for extended periods of time were initiated in 1983 by DuPont, at which time some of the armor tested had been in service for more than 8 years. Both the DuPont testing and a 1986 study by NIJ²² (*Ballistic Tests of Used Body Armor*) found that age alone does not degrade the ballistic properties of armor. Armor manufactured in 1975 that remained in inventory without issue exhibited ballistic-resistant properties identical to those at the time of manufacture. Both research studies included armor that had been in use for as long as 10 years and that had ballistic properties that were indistinguishable from those of unused armor manufactured at the same time.

NIJ tests failed to demonstrate any significant differences in 10-year-old armor, regardless of the extent of use or apparent physical condition. For this testing, 24 Type I vests made of Kevlar[®], issued as part of the original NIJ demonstration project in 1975, were returned by the departments. The vests were separated into categories based on use and wear. Eight vests had never been worn, another eight showed signs of heavy wear, and four showed signs of moderate or light wear. The test demonstrated that the armor that had been used showed no significant loss of ballistic performance when compared to the units that were not used.

In contrast, data from the DuPont study showed that used vests had lesser ballistic performance than new vests. Some vests with marginal performance had been in use for only 3 to 5 years. DuPont researchers concluded that, regardless of age, use and abuse can cause ballistic decay. For example, one poorly performing 3-year-old vest appeared to have been exposed to excessive ultraviolet radiation.

DuPont suggests that testing be considered at between 3 and 5 years of use,²³ but NIJ believes that tests are not necessary until the armor has been in service for 5 years. NIJ agrees, however, that armor should be visually inspected at least once a year and that ballistic tests should be conducted if the armor shows signs of excessive wear. If armor is worn only occasionally and properly maintained, there is no reason to be concerned that ballistic-resistant properties have deteriorated.

Independent of the above research studies, some departments have established formal replacement policies based solely on the length of time since the date of issuance. Some departments have selected 5 years for an automatic replacement cycle. Departments need to recognize that a replacement policy should be consistent with the way officers use their armor. If armor is worn only occasionally, such as tactical armor, the policy might be limited to purchasing armor for newly hired recruits and replacing a defined percentage to accommodate problems of fit or excessive wear and tear. However, a department with a high wear rate may wish to select a routine cycle, based on length of service.

Another issue relative to replacement guidelines is the manufacturer's warranty. Many body armor manufacturers currently offer a 5-year warranty on the products they sell to criminal justice agencies. This 5-year period is generally thought to be a reflection of the guidelines established by the early research conducted by DuPont. Recently, some manufacturers have offered warranties as long as for 12 years after purchase. It is important for agencies to recognize that a manufacturer's warranty should not be interpreted as a benchmark for service life. The warranty exists solely to limit the manufacturer's liability on the product and is not a reflection of the anticipated service life of the product.

For example, most new cars come with some type of manufacturer's warranty, such as 3 years or 36,000 miles, whichever comes first. The condition of each car sold under this warranty will vary due to any number of conditions (e.g., type/frequency of maintenance, variations in driving habits and conditions), but it is safe to say that the vast majority of these cars will still be operating at the end of this warranty period, and a significant number of these cars will offer many more miles of reliable service afterward. However, the manufacturer will no longer be responsible for any future major maintenance problems or cosmetic flaws. The same is true for protective armor. If the armor is properly cared for, shows no visible flaws or defects, still properly fits the officer, and still provides an adequate level of protection based upon a current assessment of the threats encountered, then it should be reasonable to presume that unit of armor is still serviceable. However, the manufacturer will not be held liable for any claims of inadequate performance after the expiration of the warranty period. For agencies that determine that it is not feasible to replace armor in accordance with a manufacturer's warranty cycle, the continued use of serviceable units of armor is definitely better than the alternative—to not wear the armor and have no protection. In this case, however, it is advisable for the agency to consult its liability insurance carrier to determine the implications this may have for its respective policy.

Testing Used Ballistic-Resistant Body Armor by Departments

It appears that until further studies are conducted and nondestructive test methods developed, a department has little choice but to periodically conduct ballistic tests of representative samples of its armor. If it can afford to, a department should initiate test programs to evaluate the ballistic-resistant protection provided by existing armor—particularly if it has armor that is more than 5 years old. The department should consider replacement if the ballistic properties of armor are questionable.

As discussed in more detail in chapter 6, the Office of Law Enforcement Standards (OLES) has developed a performance assurance program to help determine the ongoing performance of body armor currently in service or a new production unit of a previously tested and approved model. The Baseline Ballistic Limit test establishes a benchmark of penetration performance and provides a reliable and consistent way to retest NIJ-compliant armor. The ballistic limit test does not have a pass or fail performance requirement, but provides additional information about the ballistic performance of a given armor model. The ballistic limit testing is done after the armor model has successfully passed the traditional penetration and backface signature testing.

The performance assurance program is based on a modified form of ballistic limit testing, commonly known as V_{50} . (See the discussion of V_{50} testing in chapter 6, page 40.)

As a guideline, an agency should test extensively only when purchasing a significant quantity of armor. Armor testing is expensive, and departments must plan their actions based on their circumstances. For example, a department could probably buy at least four new sets of armor, depending on the threat level, for the cost of one NIJ test.

A department that elects to implement an armor-testing program for used or inservice armor must clearly establish the testing objective. Generally, this objective is to satisfy the department that its armor still provides as consistent a level of protection as when originally purchased. In these cases, the ballistic limit determination test outlined in sections 5.17 through 5.21 of NIJ Standard-0101.04 provides an abbreviated methodology for performing these tests.

An agency considering performing the ballistic limit determination test in accordance with NIJ Standard-0101.04 should initially select a sample of armor for testing that shows the heaviest signs of wear and use. This should be done for two reasons. First, it represents the “worst-case” scenario for testing, and second, it is the most logical unit of armor to be replaced, since the testing is destructive and the sample cannot be reissued after the test is completed. It is also highly recommended that the test be performed by a qualified independent testing laboratory, preferably one that is NIJ/NLECTC approved to perform compliance tests in accordance with NIJ Standard-0101.04. (A list of approved laboratories can be obtained by calling NLECTC at 800-248-2742, or from NLECTC’s Internet site, JUSTNET, at <http://www.justnet.org>.) It is important to note that these test procedures are only applicable to models of armor that comply with NIJ Standard-0101.04. A vest that complies with a previous edition of the standard cannot be tested in this manner, as no baseline ballistic limit data exists for these models.

If armor passes the test, there should be no cause for concern. If the armor fails the test, the department should not automatically assume that all of the vests of that particular model owned by the department are unsafe. Rather, this suggests that these particular used vests have questionable protection capabilities. The agency may want to consider conducting additional testing of other units of this model from the same material production lot number, which should be indicated on the ballistic panel label. This testing will help determine if the failure was an isolated one or is representative of the entire purchase lot. If further testing results in additional failures, all vests from that lot of material should be replaced. Also, agencies that experience retest failures should contact NLECTC at 800-248-2742 and arrange to have their vests compared to the originally tested vests stored in NLECTC’s archives. On several occasions, vests that have failed an agency’s retesting have been found to differ in construction from the vest originally tested by the manufacturer as part of NIJ’s voluntary compliance testing program.

When a unit of armor fails testing, the department will probably consider seeking redress from the manufacturer. Before taking such action, departments should do the following:

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- Ensure that the vests were originally tested to an NIJ standard (and to which version of the NIJ standard) before testing samples to that standard's requirements. A manufacturer can be held responsible only for the terms of the contract it signed and the standards and specifications in that contract. Unless the department's purchase contract clearly addresses testing armor in service, lists the tests that will be conducted, and specifies the department's recourse should armor fail tests, NIJ recommends that the department carefully study its situation before proceeding.
- Have the legal adviser examine the contract and any statement on the armor label to determine whether grounds for legal action exist.

If the department decides to go forward with testing, it should contact the manufacturer. Establish in advance testing objectives, action to be taken based on the test results, and the manufacturer's position concerning the nature of tests to be performed. The manufacturer should have the right to be present during the testing. Given the opportunity to work with a department to determine a mutually satisfactory course of action, reputable manufacturers will normally cooperate. Conversely, a manufacturer suddenly confronted with allegations of a problem with its product without prior indication of the department's planned actions can be expected to become defensive, if not adversarial. Also, a manufacturer may have a legitimate complaint if its product's performance is questioned based on incorrect or improper test results. Even worse, if officers know of questionable data, they may lose confidence in their armor and stop wearing it.

A department that wants to conduct its own testing must, at a minimum, have a reliable chronograph and properly conditioned backing material. The use of alternate backing material (phone books, newspapers), and of commercially loaded ammunition of unknown velocity, is certain to provide inconsistent test data that cannot be correlated to testing conducted through NLECTC's voluntary compliance-testing program.

Departments that cannot afford to conduct ballistic testing at independent laboratories should at least follow these NIJ-recommended procedures:

- Inspect each unit of armor carefully upon purchase and prior to issue. Any evidence of poor workmanship or visible differences from samples shown before purchase should be brought to the manufacturer's attention immediately.
- Ensure that each unit of armor is properly and durably labeled in accordance with the requirements of the NIJ standard. Each ballistic panel should be clearly labeled with the NIJ-complying model designation as it appears in the *Personal Body Armor Consumer Product List*.
- Upon issue, the quartermaster or supervisor responsible for issuing the equipment should use a permanent marker to legibly enter on the label the name of the officer to whom the armor is issued and the date of issue. If possible, photocopies of these labels should be made and placed in a designated file.

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- Institute a routine inspection program for body armor, just as a department would with vehicles or firearms. Develop a written policy on the frequency and extent of these inspections. At a minimum, inspect armor annually in conjunction with firearms training and qualification. The sample form in this manual (appendix E) can be used for this purpose. The International Association of Chiefs of Police (IACP) has prepared a model policy for the use of police body armor, and copies can be obtained from the association. Information on contacting IACP can be found in the resource list in appendix A.
- Instruct personnel to report any defects or damage to the body armor immediately. The quartermaster or supervisor should take immediate action to replace any body armor found to be unserviceable. NIJ does not recommend that the agency or anyone else other than the manufacturer attempt to repair damaged body armor.
- Develop written policies regarding guidelines for armor's replacement. A department must thoroughly assess its needs and requirements before instituting such a policy.

When concealable body armor was first introduced, the limits of deformation to evaluate blunt trauma protection had not yet been established. Sufficient historical data were not yet available to establish a reasonable service life for armor to provide the rated level of ballistic protection. The performance requirements for deformation were first established in 1978, when the NIJ standard was first revised. Consequently, armor purchased prior to 1978 was not tested for compliance with the current deformation requirement.

Similarly, body armor manufactured prior to 1985, when the NIJ standard was revised for the second time, was not tested for penetration resistance when struck at an angle. From 1985 to April 1987, manufacturers had their armor tested for compliance with the requirements of NIJ Standard–0101.02. Unfortunately, testing occurred prior to NLECTC's establishment and the testing program was administered differently; testing records are incomplete; and the samples tested were not retained in archival storage. Consequently, NLECTC cannot validate the results of testing done in accordance with NIJ Standard–0101.02. Should the manufacturer certification of compliance to NIJ Standard–0101.02 come into question, NLECTC cannot verify that a given armor model was in compliance with the standard or that it is identical to the armor tested.

Thus, any department with armor in its inventory that was purchased prior to the issuance of NIJ Standard–0101.03 in April 1987 might wonder whether that armor is suitable for current use or if it should be replaced. If the armor issued to officers was not tested to determine if it complies with NIJ Standard–0101.03, even if its rated level of protection (armor type) is consistent with current needs, it would be advisable to verify its performance. The only way to ensure that armor purchased to a prior edition of the NIJ standard conforms to the current requirements of NIJ standards is to test the armor. The names of NLECTC-approved independent testing laboratories (and the individuals to contact to arrange such tests) are available from NLECTC.

11. Administrative Considerations

Training and Education

Departments need to train their officers on the proper care and use of body armor and increase routine wearing of it. To encourage use, departments must educate their officers on the benefits of wearing armor. Possible approaches are discussed below. Citing the statistical information provided throughout this document can also help.

Some departments mandate that officers must wear armor at all times while on duty. When these orders are properly enforced, officers usually wear their armor. However, officers sometimes ignore these orders and relegate their armor to their locker or patrol vehicle's trunk.

Some departments find they can increase the routine use of body armor by taking advantage of the controlled setting of the police academy. These departments issue body armor to all recruits when they report to the academy and require them to wear it throughout the training period. While no firm statistics are available, it appears that such action promotes the routine use of body armor by recruits when they are assigned to duty.

Another approach is to obtain an officer's commitment to wear the armor routinely for a period of at least 1 month. Generally, the officer realizes that the armor is not as uncomfortable as expected and continues to wear the armor thereafter. While the National Institute of Justice (NIJ) is not aware of documented studies, a consensus seems to exist among most officers that the armor "softens" after a short period of wear and becomes more pliable and comfortable.

It is essential that an officer understand that there is no such thing as bulletproof armor. While wearing armor routinely can be reassuring to an officer, the officer must keep in mind that the armor was selected on the basis of limited threat protection. Additional protection, including ballistic helmets, should be worn when an officer may be exposed to a weapon threat greater than the protection provided by normal armor.

When armor is issued, departments must ensure that each officer knows the level of protection provided by the armor relative to various weapons threats. Officers also must know that body armor may not be completely effective against attack by a knife or other sharp instrument, such as an ice pick. It may not protect against bullets from high-powered rifles. The department should make clear the level of protection offered.

Any training program should emphasize the importance of using good judgment. Departments should require their officers to read the Federal Bureau of Investigation (FBI) Uniform Crime Reports publication, *Law Enforcement Officers Killed and Assaulted*. The incidents described in that report each year reinforce the importance of routine use of body armor to protect against unexpected assaults. The report encourages officers to recognize that seemingly routine assignments can end in armed confrontation.

Issuing Body Armor

Although body armor has been used for more than two decades, it is still a relatively new technology when compared to other types of police equipment. Much remains to be learned concerning its service life, and efforts continue to devise nondestructive methods of assessing the ballistic efficiency of armor that has been worn extensively.

When issuing body armor, a department's first obligation is to ensure that armor fits the officer it is issued to, for fit determines whether it will be comfortable and, to a large extent, whether it will be worn. Armor can be special ordered or tailored for those officers with unique body dimensions.

Maintaining accurate property records for all armor in inventory is essential. At any time, a department should be able to determine which armor was issued to each officer and the issue date, along with the name of the manufacturer, model number, armor type, and production lot number. The NIJ standard requires that body armor labels include a blank line for the date of issuance. The date should be entered with a permanent marking pen or stamp.

Proper records will be invaluable if a production lot is found to be defective after issuance. If a set of armor is found to be flawed, the department should inspect all armor from the same production lot, for the entire lot may be defective. Also, if armor is purchased from several manufacturers, departments can compare officer satisfaction and user experience for the different products. Good records also can assist in planning for the purchase of both new and replacement body armor.

Body armor will be frequently returned to inventory, often as the result of an officer retiring or accepting other employment. Armor may sometimes be removed from service because it no longer fits the individual to whom it was originally issued. Unless the armor shows signs of abuse, it may be reissued to another officer. NIJ strongly recommends that any unit of armor be carefully inspected prior to reissue. In one instance, an officer's life was spared only days after acquiring armor. The armor had been purchased privately by another officer who sold it upon leaving the department. The officer whose life was saved was its fifth owner.

In addition to reissuing armor to full-time police, a number of departments issue used armor that has been returned to inventory to members of their volunteer corps. Any department that has used but serviceable armor in its inventory should try to issue it to someone who will wear it.

Donating Serviceable Used Armor

Departments that buy armor in large quantities—and that may have routine, scheduled replacement policies regardless of the armor's condition—may want to consider donating armor in good condition to smaller agencies with limited budgets. However, a department should first check with its legal adviser or insurance carrier to determine if this would be permitted under

the department's liability insurance and what waivers the recipient department would be required to sign.

Disposing of Body Armor

When body armor is no longer serviceable, the department must dispose of it in a manner that will prevent illicit use. The majority of materials used in manufacturing body armor are either fire retardant or inherently fireproof, so incineration is not recommended. Cutting or shredding is, at best, a difficult and time-consuming process. Disposal in a public landfill is not recommended, because of both the potential for unauthorized parties to obtain the garments and the environmental concerns caused by disposing materials that may not be readily biodegradable.

Certain material manufacturers have an ongoing recycling program where out-of-service armor panels are destroyed by chopping the fabric into very small fragments and reusing the pulverized material in other nonballistic industrial applications. See the resource list in appendix A for contact information.

One possible option involves using the vests in the door panels of cruisers, behind desks and partitions in police station work areas, or as backstop material at indoor firing ranges. Trauma plates or hard armor inserts are not recommended for these applications due to potential ricochet hazards. If retired concealable armor is used for these applications, the department should remove ballistic materials from the vehicle or equipment before selling or disposing of it. Another option may be to discuss a possible trade-in of old vests when making a new purchase.

Liability

All administrators are painfully aware of the frequent lawsuits filed against police departments. Body armor liability centers on the protection that ballistic-resistant body armor does or does not provide.

In one incident, an officer wearing a vest was killed from an ambush with a high-powered rifle. The survivors' suit alleged that the officer did not know that the armor, intended to protect against handguns only, was incapable of protecting against a bullet from a high-powered rifle.

One individual made the fatal mistake of participating in a live demonstration of body armor involving a knife. The individual encouraged an "assailant" to attack with a knife and subsequently died from wounds received when the knife penetrated the armor. The distributor had covered the armor manufacturer's label with a second label, which stated that the armor would protect against lesser threats than the rated threat level. This resulted in a major lawsuit for compensation against several parties based on the mistaken assumption that a knife is a lesser threat than the ballistic threat specified on the armor label.

NIJ Standard–0101.04 defines levels of ballistic protection only. A knife is not a ballistic threat, and when considered in the context of the level of protection provided by ballistic-resistant body armor, it is not a lesser threat—it is an entirely different type of threat. To be considered stab or puncture resistant, body armor must be tested under NIJ’s Standard–0115.00 for stab-resistant body armor.

Because of incidents such as those described above, the NIJ standard for ballistic-resistant body armor requires that the manufacturer clearly label the level of ballistic protection that the armor is capable of providing in accordance with the types classified in the standard. In addition, the standard requires that the labels on Type I through Type III-A armor include a warning notice that the armor is not intended to protect the wearer against rifle fire and, if appropriate, that the armor is not intended to protect the wearer from sharp-edged or pointed instruments. All administrators should insist on full compliance with the labeling requirements of the standard.

When an Officer Is Shot

Although there may be no obvious sign of injury, any officer shot while wearing body armor should receive prompt medical attention. The medical staff at the R. Adams Cowley Shock Trauma Center, University of Maryland Medical System, Baltimore, states the following:

Officers and police administrators must be aware of the possibility of blunt trauma injury sustained behind body armor that has stopped a ballistic threat (i.e., not been penetrated). Any officer who has had their body armor impacted by a ballistic threat should receive a medical evaluation as soon as possible. Even though the officer shows no after effects other than soreness or a bruise, the possibility of serious internal injury still exists. A prompt medical evaluation will allow for an assessment of occult serious injury.

Before the officer returns to duty, the lifesaving armor must be replaced with a new set. Retire the armor to a trophy case to advertise gratefully the protection that it afforded. An officer once protected will undoubtedly wear body armor routinely.

Contact the International Association of Chiefs of Police/DuPont Kevlar Survivors’ Club® (see appendix A) and inform them of the incident. By sharing this information as part of the Survivors’ Club’s educational efforts, other officers will be made aware of the benefits of wearing body armor on a routine basis. As a result, other lives may be saved.

Epilogue

For more than 30 years, the National Institute of Justice (NIJ) has been committed to ensuring the safety of the Nation's law enforcement officers through its research efforts and voluntary compliance testing program for body armor. The 2,500 lives that have been spared as a result of the use of body armor bears testament to the fact that, as the National Law Enforcement and Corrections Technology Center system's motto states, "Technology Saves Lives."

The information presented in this guide emphasizes the importance of thorough planning at every step in the selection and procurement process. Police administrators and procurement officials need to be aware of the many pitfalls that can result from body armor that is either inadequate or excessive. Both cases can result in deadly consequences for the line officer. Ultimately, an agency's goal is to obtain armor that meets its needs and will be worn routinely by its officers. One thing is certain: **The only armor that is absolutely guaranteed to fail to protect the wearer is the armor that is not worn.**

Administrators should adopt policies to encourage the full-time use of body armor by field personnel. Field supervisors should set an example for officers under their command by always wearing their armor when on duty. All personnel should receive training regarding body armor's capabilities and limitations, as well as proper care methods. All armor should be routinely inspected and when it is determined that it no longer fits properly or is no longer serviceable, it should be replaced immediately.

By disseminating the information in the guide to the appropriate personnel, it is NIJ's goal to save even more lives and continue to build upon the success resulting from its body armor standards and testing program.

Endnotes

1. Source is International Association of Chiefs of Police/DuPont Kevlar Survivors' Club®.
2. The National Institute of Justice is the successor to the Law Enforcement Assistance Administration (LEAA), National Institute of Law Enforcement and Criminal Justice (NILECJ).
3. Write to NLECTC, P.O. Box 1160, Rockville, MD 20849-1160, or call 800-248-2742 or 301-519-5060.
4. Source is National Law Enforcement Officers' Memorial Fund, Inc.
5. Dean, Bashford, *Helmets and Body Armor in Modern Warfare*, New Haven, CT: Yale University Press, 1920.
6. National Institute of Law Enforcement and Criminal Justice, *Ballistic Resistance of Police Body Armor, NILECJ-STD-0101.00*, Washington, D.C.: U.S. Department of Justice, National Institute of Law Enforcement and Criminal Justice, March 1972.
7. Chappell, Kevin, "A Death-Defying Business: Fashion and Fear Fuel Sales of Bulletproof Clothing," *U.S. News & World Report*, 123:6 (August 11, 1997):46-47.
8. Source is National Law Enforcement Officers' Memorial Fund, Inc.
9. Source is the Bureau of Justice Assistance, Public Safety Officers' Benefits Program.
10. Reaves, Brian A. and Andrew L. Goldberg, *Law Enforcement Management and Administrative Statistics, 1997: Data for Individual State and Local Agencies with 100 or More Officers*, Washington, D.C.: U.S. Department of Justice, Office of Justice Programs, Bureau of Justice Statistics, April 1999, NCJ 171681.
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16. National Institute of Justice, *Ballistic Resistance of Personal Body Armor, NIJ Standard–0101.04*, Washington, D.C.: U.S. Department of Justice, National Institute of Justice, September 2000, NCJ 183651.
17. National Institute of Justice, *Stab Resistance of Personal Body Armor, NIJ Standard–0115.00*, Washington, D.C.: U.S. Department of Justice, National Institute of Justice, October 2000, NCJ 183652.
18. Federal Bureau of Investigation, *Law Enforcement Officers Killed and Assaulted*, Uniform Crime Reports, Washington, D.C.: U.S. Department of Justice, FBI, Annual.
19. Bureau of Justice Statistics, *Correctional Populations in the United States, 1997* (Executive Summary), Washington, D.C.: U.S. Department of Justice, Bureau of Justice Statistics, November 2000, NCJ 177614.
20. Bureau of Justice Statistics, *Census of State and Federal Correctional Facilities, 1995*, Washington, D.C.: U.S. Department of Justice, Bureau of Justice Statistics, August 1997, NCJ 164266.
21. *Personal Body Armor Facts Book*, DuPont, June 1994.
22. Frank, Daniel E., *Ballistic Tests of Used Body Armor*, NBSIR–86–3444, National Bureau of Standards (U.S.), August 1986.
23. See note 21 above.

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Appendix A. Resource List

The products, manufacturers, and organizations discussed in this publication are presented for informational purposes only and do not constitute product approval or endorsement by the National Institute of Justice, U.S. Department of Justice; National Institute of Standards and Technology, U.S. Department of Commerce; or Aspen Systems Corporation.

For further information on the topics, organizations, and products discussed in this publication, please contact the following:

Bulletproof Vest Partnership Grant Act (BVPGA) Program

Bureau of Justice Assistance
810 Seventh Street N.W.
Washington, DC 20531
Tel: 877-75-VESTS (877-758-3787)
Internet: <http://vests.ojp.gov>

Helps States, local governments, and tribal governments equip their law enforcement officers with armor vests.

Concerns of Police Survivors, Inc. (C.O.P.S.)

P.O. Box 3199
South Highway 5
Camdenton, MO 65020
Tel: 800-784-2677
Fax: 573-346-1414
Internet: <http://www.nationalcops.org>
E-mail: cops@nationalcops.org

Concerns of Police Survivors, Inc. provides resources to assist in rebuilding the lives of surviving family members of law enforcement officers killed in the line of duty, as determined by Federal criteria. Furthermore, COPS provides training to law enforcement agencies on survivor victimization issues and educates the public about the need to support the law enforcement profession and its survivors.

DSM High Performance Fibers, BV

Eisterweg 3
6422 PN Heerlen, the Netherlands
Tel: 31-45-5436767
Fax: 31-45-5426538
Manufacturers of Dyneema®.

DuPont Advanced Fibers Systems

Spruance Plant
P.O. Box 27001
Richmond, VA 23261
Tel: 800-453-8527
Fax: 804-383-4120
Internet: <http://www.dupont.com/afs>
Manufacturer of Kevlar® products.

**Federal Bureau of Investigation (FBI)
Uniform Crime Reports (UCR)**

Criminal Justice Information Service Division
Program Support
1000 Custer Hollow Road
Clarksburg, WV 26306
Tel: 304-625-4995
Internet: <http://www.fbi.gov/urc/ucp.htm>
Statistics on law enforcement officers killed and assaulted.

Honeywell

Spectra Performance Materials
P.O. Box 31
Petersburg, VA 23804
Tel: 800-695-5969
Fax: 804-520-3388
Internet: <http://www.honeywell.com>
Manufacturer of SPECTRA fibers.

International Association of Chiefs of Police (IACP)

515 North Washington Street
Alexandria, VA 22314-2357
Tel: 800-843-4227
Fax: 703-836-4543
Internet: <http://www.theiacp.org>
Model policies available from IACP on a wide range of law enforcement issues, including body armor.

IACP/DuPont

Kevlar Survivors' Club®

5401 Jefferson Davis Highway
Richmond, VA 23234

Tel: 800-441-2746 or 804-383-3853

Fax: 804-383-2477

Contact: Ron McBride, Law Enforcement Consultant, or Anna Knight, Club Administrator
Maintains the latest statistics on body armor "saves."

National Fraternal Order of Police (FOP)

1410 Donelson Pike, #A17

Nashville, TN 37217

Tel: 615-399-0900

Fax: 615-399-0400

Internet: <http://www.grandlodgefop.org>

E-mail: glfop@grandlodgefop.org

The FOP supports the routine use of body armor by all of its members.

National Law Enforcement Officers Memorial Fund, Inc.

605 E Street N.W.

Washington, DC 20004

Tel: 202-737-3400

Fax: 202-737-3405

Internet: <http://www.nleomf.com>

E-mail: nleomcwf@erols.com

Contact: Craig W. Floyd

Honors all law enforcement officers killed in the line of duty.

National Rifle Association (NRA)

Law Enforcement Activities Division

11250 Waples Mill Road

Fairfax, VA 22030-9400

Tel: 703-267-1640

Internet: <http://www.nrahq.org/safety/law/lebenefits.asp>

Contact: Marion Mayer

Through the NRA, selected body armor manufacturers offer discounts on their products to law enforcement officers who are NRA members.

The National “WE CARE” Foundation

P.O. Box 117617

Carrollton, TX 75011-7617

Tel: 972-492-4189

E-mail: wecare1@airmail.net

A nonprofit organization established in 1990 by the Law Enforcement Television Network (LETN) to assist police officers who are required to purchase their own body armor, but cannot afford to do so. Funds for the program are generated through the use of the Law Enforcement Visa card. A donation is made to the program every time a cardholder makes a purchase with this card. Random drawings are held to determine the recipients of the vests.

Public Safety Officers’ Benefits (PSOB) Program

Bureau of Justice Assistance

810 Seventh Street N.W.

Washington, DC 20531

Tel: 888-744-6513 or 202-307-0635

Fax: 202-307-3373

Internet: <http://www.ojp.usdoj.gov/BJA/html/specprog.htm>

The PSOB program provides financial benefits for survivors of officers killed in the line of duty and for officers permanently and totally disabled in the line of duty.

Twaron Products

801-F Blacklawn Road

Conyers, GA 30207

Tel: 800-451-6586

Fax: 770-929-8138

Internet: <http://www.twaronproducts.com>

Manufacturer of Twaron®.

Appendix B. 25 Questions and Answers About Personal Body Armor

The National Law Enforcement and Corrections Technology Center–National (NLECTC–National), located in Rockville, Maryland, administers the National Institute of Justice’s (NIJ’s) voluntary compliance testing programs for personal body armor. In addition to processing samples received for testing, NLECTC–National staff routinely respond to inquiries received from law enforcement, corrections, other criminal justice agencies, and product manufacturers about the testing program. The 25 most frequently asked questions regarding the body armor testing programs and their corresponding answers that follow are provided as part of NLECTC–National’s commitment to provide timely and accurate information to the user community. If you have a question that is not found in this document, please contact NLECTC–National by telephone at 800–248–2742 or 301–519–5060, by fax at 301–519–5149, or by e-mail at asknlectc@nlectc.org.

Q: We’re going to purchase body armor in the near future. Do you have any advice or suggestions?

A: *Selection and Application Guide to Personal Body Armor, NIJ Guide 100–01*, contains important information to assist agencies and individual officers in selecting, purchasing, and caring for body armor. Recently, NIJ has introduced two new body armor standards (one for ballistics and one for stab and puncture resistance). To obtain a copy of the most current version, call NLECTC at 800–248–2742 or 301–519–5060, or download a copy from <http://www.justnet.org>.

Also, funds are available through the Bulletproof Vest Partnership Grant Act (BVPGA), administered by the Bureau of Justice Assistance (BJA), to assist law enforcement and corrections agencies with the purchase of ballistic- and stab-resistant armor. The BVPGA will provide funds to pay for up to half of the purchase price of armor models found to comply with NIJ standards. For more information on how to apply for these funds, visit the BVPGA World Wide Web site at <http://vests.ojp.gov>.

Q: How does ballistic-resistant body armor work?

A: When a bullet strikes a body armor panel, the fibers absorb and disperse the energy of the impact across a generalized area. Most concealable body armor is made of a number of layers; these layers assist in the energy dispersion process and help to reduce the effects of blunt trauma, caused by the force of the impacting projectile.

Q: How does stab- and puncture-resistant body armor work?

A: Stab- and puncture-resistant armors are made from a variety of materials. The most commonly used materials are made from extremely strong fibers, which can either be woven or laminated together. Other materials used are metals and composites. As the threat impacts the armor, the materials either deflect the threat, or due to their very high level of cut and/or tear resistance, they “stretch” and the impact forces are dissipated over a larger area of the armor.

Q: Is ballistic-resistant armor also stab/puncture resistant (or vice versa)?

A: The materials technology that makes body armor ballistically resistant does not necessarily make it stab or puncture resistant (and vice versa). The IACP/DuPont KEVLAR Survivors Club® has documented a number of incidents over the years in which ballistic-resistant armor has provided some protection against attacks from a variety of sharp-edged and other weapons (e.g, clubs.). However, one should not presume that a ballistic-resistant vest will protect against nonballistic threats, or that a stab-resistant vest provides ballistic protection. Armor that complies with NIJ standards will clearly identify the types and level of threats that they are designed to protect against.

Q: What types of ballistic-resistant materials are used to make body armor?

A: Body armor can be made from a number of different types of woven or nonwoven materials. One of the first fibers used for modern ballistic-resistant material was Kevlar®, which is made by DuPont. Other materials include Spectra®, which is made by Honeywell (formerly AlliedSignal); Twaron®, made by Accordis (formerly Akzo Nobel), and Zylon®, made by Toyobo. These materials are manufactured in a variety of styles, and can be woven or nonwoven (laminated). Hard (nonfabric) armor plates can be made from a number of materials, including metals, ceramics, and other composite materials.

Q: Which ballistic- or stab-resistant material is better?

A: The NIJ standards for personal body armor (ballistic and stab/puncture resistant) establish minimum performance requirements to evaluate specific designs or “models” of armor. The standard is not intended to be a design specification, which would require manufacturers to use a specific type of material and/or design pattern to achieve a required level of protection. Instead, by measuring only the performance capabilities of the model, this allows armor manufacturers the ability to innovate by using any type or combination of types of materials, as well as design methods, to achieve the required level of protection.

Q: What new technologies have been developed for body armor?

A: Over the past 20 years, new materials and fabrics have been introduced that have contributed significantly to the wearability of body armor. Body armor manufacturers also have made a number of advances in design technology, resulting in body armor that has increased ballistic protection capabilities, more flexibility, less weight, and is ultimately more comfortable. New materials also have been developed that provide protection against sharp-edged and pointed weapons.

Q: Is there a difference between male and female models of armor?

A: Generally speaking, the difference between male and female models is that for female body armor, most manufacturers cut and stitch the material to create bust cups. This is why the NIJ standard views male and female vests as separate models, even though they may be made of exactly the same type and sequence of layers of ballistic materials. When a female model is tested, the laboratory is instructed to locate the seam that is created by folding and/or stitching

the material to make the bust cup, and to place one of the shots on that seam. This is done to ensure the weakest point of the vest (typically a seam) provides the minimum level of ballistic protection required by the standard.

It is important to note that this is a generalization. There are many different types and styles of female vests, and different ways of fitting vests to accommodate all of the various sizes and shapes needed for female officers. Some manufacturers have developed methods that “mold” the bust cups into the material, negating the need for cutting and stitching to create a bust cup. Other manufacturers simply alter the outside dimensions of the panel (e.g., enlarging the arm hole openings) to accommodate certain types of builds and body types (commonly referred to as a “unisex” vest).

In summary, when selecting a female vest, NIJ and NLECTC recommend that an agency look at and have its officers try on a variety of models from different manufacturers that have been tested and found to comply with the NIJ standard for personal body armor. This will assist in selecting the model that provides the best combination of comfort, fit, protection capability, and accessories and features. Be sure to ask the manufacturer’s representative about ongoing customer support and what steps they will take to properly measure and fit the vests, as well as making adjustments once the vests have been delivered. Ask the representative for references from other agencies that have purchased their armor, and contact other agencies in your area who have recently purchased armor to learn about their experiences.

Q: What type and threat level of armor should I wear?

A: First, assess the type of threat you face on a daily basis. Review data from shooting incidents in your area, as well as the types of weapons (firearms, knives, etc.) being confiscated from suspects. Also factor in what type of sidearm and duty ammunition you are carrying. FBI Uniform Crime Report (UCR) data indicate that approximately one in six officers who are killed in the line of duty are shot with their own weapon. Other considerations are the climate in which you work, typical duty assignment, and personal preference considerations (comfort and fit). Again, the decision is ultimately yours. The same concepts apply for correctional officers seeking stab- or puncture-resistant armor.

Q: What are trauma plates?

A: Trauma plates are devices that can be added to the vest over a localized area (most commonly the mass center of the torso) to increase the wearer’s protection against blunt trauma injuries. Blunt trauma injuries are caused by the impact forces of the bullet against the armor, resulting in nonpenetrating internal injuries such as bruises, broken ribs, or other injuries to internal organs. Trauma plates can be made of a hard substance such as metal wrapped in rubber or ballistic fabric, or they can be made of additional layers of ballistic fabric, similar to an armor panel. Some manufacturers even build trauma plates into the armor panel itself.

Q: Which manufacturer makes the best body armor?

A: The NIJ standards for personal body armor (ballistic and stab/puncture resistant) and the voluntary compliance testing programs operated by NLECTC exist to ensure that models of armor offered for sale to law enforcement and corrections personnel are safe, reliable, and meet minimum performance requirements. Neither NIJ nor NLECTC “endorse” any particular manufacturer or model of armor, but provide a complete listing of all models that have been tested and found to comply with the NIJ standard. You can access this list, which is updated continuously, through our Internet site at <http://www.justnet.org>. If you do not have access to the Internet, you can also call NLECTC at 800-248-2742 or 301-519-5060 to get the most current information on models that comply with the standard.

Q: What is the best way to care for body armor?

A: Follow the manufacturer’s care instructions provided with your armor or refer to the instructions on the armor labels. Failure to follow these instructions may damage the ballistic performance capabilities of the armor. The *Selection and Application Guide to Personal Body Armor* contains general guidelines on how to properly care for armor. This document can be obtained by calling NLECTC at 800-248-2742 or 301-519-5060, or can be downloaded from <http://www.justnet.org>.

Q: How long does body armor last?

A: There are a number of factors that can influence the service life cycle of body armor. NIJ has sponsored research that indicates that age is not the only factor in determining the service life of armor. Other factors to consider include: how regularly the armor is worn, how it is cared for, how properly it fits the wearer (most people lose or gain weight over a period of years), and the overall condition of the armor (e.g., Do the fasteners still work properly?). We encourage departments to have a routine inspection program for body armor, just as they would for weapons, vehicles, and other types of issued equipment. The *Selection and Application Guide to Personal Body Armor* contains a sample form that can be used as a checklist when inspecting armor.

Q: How do I dispose of my old vest?

A: Check with your department to see if it has a policy regarding the disposal of used body armor. If they do not, there are several organizations that accept donations of used vests for distribution to law enforcement agencies here in the United States. Check with your local Fraternal Order of Police. If you are not comfortable donating your armor to another agency, you may also contact the manufacturer of your vest to determine if it will dispose of your armor. Some agencies also have used retired armor in the door panels of police cars or special operations vehicles.

Q: I understand that NIJ has published a new standard for ballistic-resistant armor. What are the major differences between the new version and NIJ Standard–0101.03?

A: In September 2000, NIJ released *Ballistic Resistance of Personal Body Armor, NIJ Standard–0101.04*. This revision, the first of this standard in 13 years, was the result of a 3-year effort that included input from the law enforcement, body armor manufacturing, and fiber manufacturing communities. The Office of Law Enforcement Standards (OLEs) coordinated the development of this new revision, performing most of the research with support from various components of the NLECTC system.

Technical highlights of the new standard (0101.04) include:

- Updated test rounds for certain NIJ armor types, replacing outdated or obsolete ammunition:
 - For Type I armor, the .38 Special has been replaced by the .380 ACP.
 - For Type IIA, the .357 Magnum has been replaced by the .40 S&W.
 - For Type IIIA, the .44 Magnum remains, but the test bullet has been changed to a semi-jacketed hollow point (SJHP) from the lead semi-wadcutter gas check (LSWGC), which is no longer manufactured.

All other test rounds remain unchanged from NIJ Standard–0101.03.

- A second backface signature (BFS) measurement on each panel.
- A single environmental test condition (wet).
- Restoration of the armor’s original physical condition between impacts (commonly referred to as “pat-down”).
- A Baseline Ballistic Limit test to establish benchmark penetration performance of the armor, which is useful for enhanced understanding of its protection, and to provide a consistent baseline for any future retesting that might be required.

Q: Do models that comply with NIJ Standard–0101.03 automatically comply with NIJ Standard–0101.04?

A: No. NIJ still continues to recognize the compliance status of models found to comply with NIJ Standard–0101.03 to that edition of the standard. If a manufacturer desires to submit a model of 0101.03-compliant armor to NLECTC for testing to 0101.04, they can, and if it is found to comply with 0101.04, then it will be recognized as complying with *both* editions of the standard.

Q: OK, but what happens if that 0101.03-compliant model fails to comply with the requirements of 0101.04?

A: Models that comply with NIJ Standard–0101.03 cannot “lose” their compliance status to that edition of the standard if they do not comply with the requirements of 0101.04. The model will

still be recognized as compliant with 0101.03, but cannot be considered for further testing to 0101.04.

Q: Can manufacturers still submit new models of armor for testing to NIJ Standard–0101.03?

A: No. As of October 2, 2000, all models of armor submitted to NLECTC for compliance testing will be tested in accordance with NIJ Standard–0101.04.

Q: Is armor that complies with NIJ Standard–0101.04 “better” than armor that complies with NIJ Standard–0101.03?

A: **NO.** It has only been tested to a different version of the standard. The development of NIJ Standard–0101.04 incorporates the knowledge and experience that has been gained in the past 13 years of armor testing, takes into account the advances in materials and design technology that have occurred in the industry, and updates the threats which the armor is tested against. It is simply the next evolutionary step in the development of NIJ’s voluntary compliance testing program for ballistic-resistant armor, ensuring that law enforcement and corrections officers have access to armor that is safe, reliable, and meets currently defined protection needs.

Q: With the release of NIJ Standard–0101.04, does this mean that we have to replace all the armor we have that complies with NIJ Standard–0101.03, including those we just purchased?

A: **NO.** The advent and exclusive use of NIJ Standard–0101.04 in the Voluntary Compliance Testing Program does not imply that existing NIJ Standard–0101.03 compliant armor is in any way unsuitable for continued purchase and everyday use. In fact, such armor will still provide the same proven high degree of protection and performance that NIJ Standard–0101.03 demanded and produced. NIJ Standard–0101.03 compliant armor should not be considered inadequate or obsolete; it is simply armor that has not been tested and found compliant to NIJ Standard–0101.04’s different requirements.

Q: If a manufacturer offers to sell us a model that complies with NIJ Standard–0101.03, should we purchase it?

A: If you determine that this model meets all of your protection and user defined requirements, **then there is no reason not to purchase it.** NIJ Standard–0101.03 compliant armor should not be considered inadequate or obsolete; it is simply armor that has not been tested and found compliant to NIJ Standard–0101.04’s different requirements.

Q: I’m a correctional officer, and I’m more interested in a vest that provides stab/puncture protection instead of ballistic protection. What assistance can you provide?

A: For almost 30 years, NIJ has been a leader in the development and testing of ballistic-resistant armor. In September 2000, NIJ released *Stab Resistance of Personal Body Armor, NIJ Standard–0115.00*. This standard is the result of a 3-year collaborative effort between the Office of Law Enforcement Standards, the U.S. Secret Service, and the Police Scientific Development Branch of the United Kingdom, and establishes the first national minimum performance

requirements for stab- and puncture-resistant armor. NIJ Standard–0115.00 classifies armor into two protection classes, spike (puncture-resistant) and edged blade. For each protection class, there are three protection levels against which the armor can be tested. A voluntary compliance testing program has been established by NLECTC in accordance with this new standard, and models found to comply are listed in the Body Armor Database at <http://www.justnet.org>.

It is also important to note that armor models found to comply with NIJ Standard–0115.00 are also eligible for funding under the Bulletproof Vest Partnership Grant Act (BVPGA). For more details, visit the BVPGA Web site at <http://vests.ojp.gov>.

Q: Who tests the armor to determine if it complies with NIJ Standards?

A: Only NIJ-approved independent testing laboratories are recognized as official testing facilities for compliance testing to NIJ standards. A complete list of NIJ-approved laboratories can be found on JUSTNET at <http://www.justnet.org>, or call NLECTC at 800–248–2742 or 301–519–5060.

Q: How is armor submitted for testing?

A: The manufacturer submitting an armor model for testing must first negotiate a testing contract with an NIJ-approved testing laboratory. Neither NIJ nor NLECTC accepts any payment for testing services. The manufacturer then submits samples to NLECTC, where they are examined for workmanship and labeling requirements, which are defined in the NIJ standards. If the samples successfully complete this examination, they are sent to the approved laboratory with whom the manufacturer has negotiated the testing contract. The laboratory performs the test in accordance with the standard, and prepares a report of the test. The samples and the report are returned to NLECTC, where they are again examined and compared to the laboratory report. If the armor complies with the standard, a letter is issued to the manufacturer for that model and the model is listed on the *Personal Body Armor Consumer Product List (CPL)*, which can be accessed at <http://www.justnet.org>.

Q: How does a laboratory obtain NIJ approval to conduct body armor testing?

A: To become an NIJ-approved laboratory, the laboratory must submit an application (available from NLECTC) that will be reviewed by NIJ to determine if the laboratory is technically capable of performing the testing. NLECTC will then conduct an onsite inspection that includes witnessing the testing of actual samples. The laboratory prepares a report of the test and returns the tested samples and report to NLECTC, where they are checked for accuracy. If the laboratory successfully completes all of these requirements, NIJ will issue a letter to the laboratory notifying it that it is an NIJ-approved laboratory and is authorized to conduct testing in accordance with NIJ standards. Manufacturers and other interested parties also will be notified of the laboratory's status. NIJ accepts applications from interested laboratories on a continuing basis. Laboratories seeking NIJ-approved status should contact NLECTC at 800–248–2742 or 301–519–5060. It is also important to note that laboratories are approved to perform testing in accordance with a specific NIJ standard. A test laboratory must complete a separate application and go through the complete approval process for each NIJ standard for which it wishes to perform testing.

Appendix C. The Effect of Body Armor on the Risk of Fatality in Felonious Assaults on Police Officers*

*Source: FBI Uniform Crime Reports: *Law Enforcement Officers Killed and Assaulted*, 1994.

The move by law enforcement to equip its officers with high-quality body armor to better protect them in the event of an assault with a firearm is among the most visible and important contributions to safety in the history of policing. There has never been any serious debate raised about the logic or wisdom of equipping officers with body armor. While body armor is often described as uncomfortable, its use is nonetheless encouraged by most departments and required by many.

Past studies have attempted to determine the actual effectiveness of body armor in protecting the lives of law enforcement officers. These studies could not quantify the protective capabilities of body armor due to a lack of sufficient research design. Fundamentally, the research has been used to show the high percentage of deceased officers who were not wearing body armor at the time they were slain. What these studies attempted, but failed to quantify, was the actual protection provided by body armor.

A Federal Bureau of Investigation (FBI) study on protection provided by body armor has shown that the risk of fatality for officers assaulted with a firearm while not wearing body armor is 14 times higher than for officers wearing body armor. The study methodology, known as case-control design, was used to quantify the protection provided by body armor. This approach has been used in medical and public health research such as in the early 1950s and 1980s when it was used to identify the risks associated with smoking and toxic shock syndrome. In this study, it is applied to identify the risk of fatality associated with not wearing protective body armor during an assault with a firearm. This study compares a group of officers who survived an assault with a firearm to a group of officers assaulted with a firearm and slain. Members of both groups were shot with a firearm in the upper torso area, the area traditionally covered by body armor.

A comprehensive FBI database on law enforcement officers killed in the line of duty includes information on whether an officer was wearing body armor at the time of the attack. For this study, cases were selected based on the criterion of whether the officer was shot in an area that could be covered by conventional body armor (i.e., front and rear upper torso). Officers fatally wounded in the head, extremities, or other areas not traditionally covered by body armor were excluded. A group of 25 officers feloniously killed in the line of duty was randomly selected from an available 133 officers who met the initial criteria.

A similar selection process was used to select officers who survived an assault with a firearm. During 1992, the FBI expanded its data collection and solicited information on law enforcement officers who were seriously assaulted in the line of duty and survived. From the cases submitted to the FBI, a small comparison group was produced. This comparison group consisted of 25

officers who survived after being shot with firearms in the upper torso. The officers in the separate groups differed only on the survival outcome of their assaults. By comparing the survival outcome of the officers based on their use of body armor, a risk factor can be computed for the odds of fatality for officers shot in the upper torso while not wearing body armor.

In the following table, the relative risk of fatality for officers not wearing body armor is computed. The first column lists the total, 25 officers, who did not survive an assault with a firearm. As shown, only four of the slain officers were wearing body armor at the time of the assault. In contrast, for officers that survived, 18 wore armor at the time of the assault. The odds of fatality for officers not wearing armor is computed as (21/7), or 3. The odds of fatality for officers wearing armor is computed as (4/18), or .22. To arrive at the relative risk between the two groups, the odds of fatality while not wearing armor are divided by the odds of fatality while wearing armor (3/.22), or 13.5. This number can be interpreted as the odds, or relative risk, of fatality. For an officer shot in the torso while not wearing body armor, the relative risk of fatality is 14 times higher than for an officer who is wearing body armor. Equation 1 shows the computation of the relative risk (Ψ).

Table 1.	Deceased	Alive	Total
No Armor	21	7	28
Armor	4	18	22
Total	25	25	50

Eq. 1.
$$\Psi = (21 * 18)/(7 * 4) = 13.5.$$

While the absolute risk of fatality could not be computed in this study, it is clear that officers who are not wearing armor at the time of an assault with a firearm are at significantly greater risk of fatality than officers who are wearing body armor at the time of assault. Further, this relative risk of term (Ψ) is not influenced by sample size, so it is likely that this relative risk of fatality would have been observed in samples of any size.

The results of this study affirm what law enforcement trainers have long been telling officers: body armor saves lives. By wearing body armor, a law enforcement officer can significantly increase his or her chances of surviving an assault with a firearm.

Appendix D. Model Procurement Specifications

Terms of agreement

A) Specific Quantity

The (jurisdiction) intends to purchase a total of (number spelled out) (number) units of body armor.

Of this total, (number spelled out) (number) shall be specially designed for issue to female officers. The successful bidder further agrees to supply the same model of armor at the unit price cost of the above quantity order for an additional period of (select appropriate period of time) months for issue to new officers or replacement purposes.

B) Open End Purchase Agreement (Term Contract)

The (jurisdiction) anticipates the purchase of a total of (number spelled out) (number) units of body armor during a (appropriate period of time)-month period beginning on or about (date). During this period, purchase orders will be issued for armor as needed at the contract unit price. It is estimated that (number) percent of the armor purchased will be specifically designated for issue to female officers. The term of this agreement shall be (appropriate period of time) months; however, the (jurisdiction) does not guarantee the purchase of any specific or minimum quantity of armor during the term of this agreement. The (jurisdiction) may, at its option and subject to agreement by the contractor, extend the term of this agreement at the same contract unit price for an additional period of (appropriate period of time) months.

Bidding and award

Bids shall be submitted (specify standard departmental regulations; i.e., departmental form, letter quotation, etc.).

Bids will be accepted only for armor that has been tested by an independent testing laboratory as part of the National Institute of Justice (NIJ) National Law Enforcement and Corrections Technology Center (NLECTC) body armor compliance-testing program and found to fully comply with the requirements of NIJ Standard-0101.04 (or current edition) or NIJ Standard-0115.00 for stab-resistant armor.

The (jurisdiction) reserves the right to reject any or all bids in whole or in part as it is deemed in the best interest of the department.

In determining the most advantageous bid, the (jurisdiction) reserves the right to consider quality, workmanship, service, and dependability of the product and manufacturer, independent of price.

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The successful bidder agrees to provide (name of manufacturer) model (designation) armor properly identified on the label of each unit of armor.

Note: The model selected, which must be verified as having been tested by a NLECTC-approved testing laboratory and found to comply with NIJ Standard–0101.04 or 0115.00, must be incorporated in this document or separate purchase document at the time of award of said contract.

Prebid conference

Specify date, time, and location. If attendance is a condition of bid acceptance, this must be noted.

Invoicing and delivery

Specify consistent with the normal procurement practices of the jurisdiction.

Warranty and insurance

Each unit of armor provided under this contract shall be warrantied for a minimum of (number spelled out) (number) years to be free from all defects in materials and workmanship.

Each unit of armor provided under this contract shall be warrantied for a minimum of (number spelled out) (number) years to meet the ballistic-resistant and deformation requirements of NIJ Standard–0101.04 (or NIJ Standard–0115.00 for stab-resistant models).

Manufacturers shall have a product liability performance insurance policy in a minimum amount of (specify per incident and total liability limits, and period of coverage as appropriate based upon recommendations of department’s legal counsel and insurance commission). All insurance policies shall conform to the rules and regulations of (appropriate jurisdiction).

Armor specifications

Each unit of armor shall be new, unused, constructed of the highest quality materials, and shall:

A) Be constructed identically to the original model tested by NLECTC and found to comply with the minimum performance requirements for Type (appropriate classification) armor as specified in NIJ Standard–0101.04 (or current edition) or NIJ Standard–0115.00 for stab-resistance.

B) Be labeled in accordance with the requirements of NIJ Standard–0101.04 or NIJ Standard–0115.00, clearly identifying the exact manufacturer model and, if appropriate, style specified in the contract document.

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The manufacturer may, at its option, include in addition a catalog number for supplier or distributor convenience, provided that such number is properly identified and totally separate from the model/style designation line. Labels shall remain readable throughout the warranty period.

- C) Be designed to be concealable under the standard (jurisdiction) uniform shirt. Provide full torso coverage, with front-to-back side overlap of ballistic panels. (Alternately, state other side protection requirements or other intended manner of use, such as a specific type of outerwear, i.e., tactical vest.)
- D) Provide adjustment for the chest, waist, and shoulders with the minimum relief under arms, neck, and shoulder necessary to prevent chafing of the wearer.
- E) Be designed in such a manner as to prevent the armor from “riding up” on the wearer during normal duty activities.
- F) All closure, fastening, or accessory attachment devices should be made of materials that do not present a “secondary projectile” or “ricochet” hazard if struck by a bullet.
- G) Incorporate a carrier for the ballistic element that is (appropriate choice) in color, and the coloring shall be permanent and not “bleed” onto other garments.
- H) Be free from any defects affecting durability, serviceability, appearance, or the safety of the user. Workmanship and construction details, cutting, stitching, and finishing shall be in all cases in accordance with first-class commercial textile standard practices for the intended purpose.

Items to be submitted with the bid

- A) Sample of armor model being bid, labeled in accordance with the requirements above (item B, armor specifications).

Note: The sample provided by the successful bidder will become the property of (jurisdiction) and retained in archives for comparison with armor delivered under the resulting contract. Samples provided by unsuccessful bidders will be returned F.O.B.¹ (jurisdiction and shipping address) upon request following contract award.

- B) Proof that the armor model offered has been tested by a NLECTC-approved laboratory and that NLECTC has found that model to be in full compliance with the requirements of NIJ Standard–0101.04 or NIJ Standard–0115.00.
- C) Proof of liability insurability.
- D) List of customers to whom the bidder has satisfactorily sold armor during the past three (3) years.

1. The risk of loss if goods are damaged or lost in transit with the Seller or the Buyer, depending on the shipping terms negotiated. The term F.O.B. means Free on Board, which means only that the Seller will place goods in or on the carrier's equipment without cost to the Buyer.

Termination of agreement

See commentary.

Acceptance testing

See commentary.

Appendix E. Body Armor Inspection Sheet

Date: _____

Manufacturer: _____ Model/Style _____

Male _____ Female _____ Size _____

Serial Number: _____

Issued To: _____

Inspected By: _____

Yes No

A. Labeling:

- | | | |
|-------|-------|---|
| _____ | _____ | 1. Is a label securely attached to each part of the carrier and ballistic- or stab-resistant panels? |
| _____ | _____ | 2. Is information on the labels legible? |
| _____ | _____ | 3. Does the model comply with NIJ Standard-0101.04 (or NIJ Standard-0115.00 for stab-resistant models)? |

B. General Condition/Appearance

- | | | |
|-------|-------|--|
| _____ | _____ | 1. Does the carrier or permanent cover have any visible rips/tears/holes? |
| _____ | _____ | 2. Is the armor relatively clean and free of dirt and debris? |
| _____ | _____ | 3. Are closure devices securely attached to the vest and operating properly? |
| _____ | _____ | 4. If protective element is encased in a nonremovable cover, is any material (fabric) exposed? |
| _____ | _____ | 5. If protective element is not encased in a nonremovable cover, is the material frayed? |
| _____ | _____ | 6. Are there creases in the armor? |
| _____ | _____ | 7. Is the armor free from odor? |

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Yes No

C. Care and Maintenance

_____ _____

1. Does the officer responsible for the vest understand and follow the manufacturer's care and cleaning instructions?

_____ _____

2. Does the officer responsible for the vest understand and follow department policy regarding care, maintenance, and wearing of vest (if applicable)?

D. Size/Fit

_____ _____

1. Does the vest fit the officer properly and securely?

E. Overall Evaluation:

_____ Excellent/New _____ Good _____ Fair _____ Poor

Comments:

Appendix F. Law Enforcement and Corrections Technology Advisory Council

Chair: Carl R. Baker

Vice Chair: Michael Maloney

Vice Chair: Kenneth Bayless

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Appendix H. About the National Institute of Justice

NIJ is the research and development agency of the U.S. Department of Justice and is the only Federal agency solely dedicated to researching crime control and justice issues. NIJ provides objective, independent, nonpartisan, evidence-based knowledge and tools to meet the challenges of crime and justice, particularly at the State and local levels. NIJ's principal authorities are derived from the Omnibus Crime Control and Safe Streets Act of 1968, as amended (42 U.S.C. §§ 3721–3722).

NIJ's Mission

In partnership with others, NIJ's mission is to prevent and reduce crime, improve law enforcement and the administration of justice, and promote public safety. By applying the disciplines of the social and physical sciences, NIJ—

- **Researches** the nature and impact of crime and delinquency.
- **Develops** applied technologies, standards, and tools for criminal justice practitioners.
- **Evaluates** existing programs and responses to crime.
- **Tests** innovative concepts and program models in the field.
- **Assists** policymakers, program partners, and justice agencies.
- **Disseminates** knowledge to many audiences.

NIJ's Strategic Direction and Program Areas

NIJ is committed to five challenges as part of its strategic plan: 1) **rethinking justice** and the processes that create just communities; 2) **understanding the nexus** between social conditions and crime; 3) **breaking the cycle** of crime by testing research-based interventions; 4) **creating the tools** and technologies that meet the needs of practitioners; and 5) **expanding horizons** through interdisciplinary and international perspectives. In addressing these strategic challenges, the Institute is involved in the following program areas: crime control and prevention, drugs and crime, justice systems and offender behavior, violence and victimization, communications and information technologies, critical incident response, investigative and forensic sciences (including DNA), less-than-lethal technologies, officer protection, education and training technologies, testing and standards, technology assistance to law enforcement and corrections agencies, field testing of promising programs, and international crime control. NIJ communicates its findings through conferences and print and electronic media.

NIJ's Structure

The NIJ Director is appointed by the President and confirmed by the Senate. The NIJ Director establishes the Institute's objectives, guided by the priorities of the Office of Justice Programs, the U.S. Department of Justice, and the needs of the field. NIJ actively solicits the views of criminal justice and other professionals and researchers to inform its search for the knowledge and tools to guide policy and practice.

NIJ has three operating units. The Office of Research and Evaluation manages social science research and evaluation and crime mapping research. The Office of Science and Technology manages technology research and development, standards development, and technology assistance to State and local law enforcement and corrections agencies. The Office of Development and Communications manages field tests of model programs, international research, and knowledge dissemination programs. NIJ is a component of the Office of Justice Programs, which also includes the Bureau of Justice Assistance, the Bureau of Justice Statistics, the Office of Juvenile Justice and Delinquency Prevention, and the Office for Victims of Crime.

To find out more about the National Institute of Justice, please contact:

National Criminal Justice Reference Service

P.O. Box 6000

Rockville, MD 20849-6000

800-851-3420

E-mail: askncjrs@ncjrs.org

To obtain an electronic version of this document, access the NIJ Web site

(<http://www.ojp.usdoj.gov/nij>).

If you have questions, call or e-mail NCJRS.

Appendix I. 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 directed NIJ 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 nationwide and internationally.

The program operates through the following:

- The **Law Enforcement and Corrections Technology Advisory Council (LECTAC)**, consisting of nationally recognized criminal justice practitioners from Federal, State, and local agencies, assesses technological needs and sets priorities for research programs and items to be evaluated and tested.
- The **Office of Law Enforcement Standards (OLES)** at the National Institute of Standards and Technology develops voluntary national performance standards for compliance testing to ensure that individual items of equipment are suitable for use by criminal justice agencies. The equipment standards developed by OLES are based on laboratory evaluation of commercially available products in order to devise precise test methods that can be universally applied by any qualified testing laboratory and to establish minimum performance requirements for each attribute of a piece of equipment that is essential to how it functions. OLES-developed standards can serve as design criteria for manufacturers or as the basis for equipment evaluation. The application of the standards, which are highly technical in nature, is augmented through the publication of equipment performance reports and user guides. Individual jurisdictions may use the standards in their own laboratories to test equipment, have equipment tested on their behalf using the standards, or cite the standards in procurement specifications.
- The **National Law Enforcement and Corrections Technology Center (NLECTC)**, operated by a grantee, supervises a national compliance testing program conducted by independent laboratories. The standards developed by OLES serve as performance benchmarks against which commercial equipment is measured. The facilities, personnel, and testing capabilities of the independent laboratories are evaluated by OLES prior to testing each item of equipment. In addition, OLES helps NLECTC staff review and analyze data. Test results are published

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in consumer product reports designed to help justice system procurement officials make informed purchasing decisions.

Publications are available at no charge through NLECTC. Some documents are also available online through the Justice Technology Information Network (JUSTNET), the center's Internet/World Wide Web site. 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.justnet.org>

Appendix J. About the National Law Enforcement and Corrections Technology Center System

The National Law Enforcement and Corrections Technology Center (NLECTC) system exists to support the Nation's structure of State and local law enforcement and corrections. The United States has more than 18,000 law enforcement agencies, 50 State correctional systems, and thousands of prisons and jails. The fragmented nature of law enforcement and corrections impedes the dissemination of valuable new information, fosters a patchwork marketplace that discourages the commercialization of new technologies, and underscores the need for uniform performance standards for equipment and technologies.

The National Institute of Justice's (NIJ's) Office of Science and Technology (OS&T) created NLECTC in 1994 as a national system of technology centers that are clearinghouses of information and sources of technology assistance and that also attend to special needs, including technology commercialization and standards development.

The NLECTC system's purpose is to determine the needs of the law enforcement and corrections communities and assist them in understanding, using, and benefitting from new and existing technologies that, increasingly, are vital levers of progress in criminal justice. NIJ/OS&T and the NLECTC system are the only current programs developed by the Federal Government that focus solely on the development and transfer of technologies to State and local law enforcement and corrections.

NLECTC is a program of NIJ, the research and development arm of the U.S. Department of Justice. The system currently consists of a national center, five regional centers, and several speciality offices. Also contributing to the initiatives of the center system is the Office of Law Enforcement Standards. The centers are colocated with a host organization or agency that specializes in one or more areas of technology research and development.

The National Center, located in Rockville, Maryland, is the system's information hub. Regional centers are currently located in Alaska, California, Colorado, New York, and South Carolina. Speciality centers located around the country deal with border matters (California), commercialization of law enforcement and corrections technologies (West Virginia), rural law enforcement issues (Kentucky), and standards and testing (Maryland).

Each center shares roles with the other centers and has distinctive characteristics. All are focused on helping law enforcement and corrections take full advantage of technology's rapidly growing capacity to serve the purposes of crime control and the criminal justice system.

A national body of criminal justice professionals, the Law Enforcement and Corrections Technology Advisory Council (LECTAC), helps identify research and development priorities, thereby influencing the work of the NLECTC system. In addition, each NLECTC center has a regional advisory council of law enforcement and corrections officials. Together, LECTAC and the advisory councils help to keep the NLECTC system attentive to technological priorities and

the needs of law enforcement and corrections. They help to link the end user with the developer to create technologies that adequately meet operational requirements and establish which potential technologies should be pursued for development.

All of the current regional centers have distinctive roles or focus areas, that, in many cases, are aligned with the expertise of host organizations and agencies. The centers are currently operated under cooperative agreements or interagency agreements with host organizations and agencies whose employees staff the centers.

To receive more information or to add your name to the NLECTC mailing list, 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.justnet.org>

The following is a list of NLECTC regional and affiliated facilities that assist NIJ in fulfilling its mission.

NLECTC-Northeast

26 Electronic Parkway
Rome, NY 13441-4514
(p) 888-338-0584
(f) 315-330-4315
E-mail: nlectc_ne@rl.af.mil

NLECTC-Southeast

5300 International Boulevard
North Charleston, SC 29418
(p) 800-292-4385
(f) 843-760-4611
E-mail: nlectc-se@nlectc-se.org

NLECTC-Rocky Mountain

2050 East Iliff Avenue
Denver, CO 80208
(p) 800-416-8086
(f) 303-871-2500
E-mail: nlectc@du.edu

NLECTC-West

c/o The Aerospace Corporation
2350 East El Segundo Boulevard
El Segundo, CA 90245-4691
(p) 888-548-1618
(f) 310-336-2227
E-mail: nlectc@law-west.org

NLECTC-Northwest

4000 Old Seward Highway
Suite 301
Anchorage, AK 99503-6068
(p) 866-569-2969
(f) 907-569-6939
E-mail: nlectc_nw@ctsc.net

Border Research and Technology Center

1010 Second Avenue
Suite 1920
San Diego, CA 92101
(p) 888-656-2782
(f) 888-660-2782
E-mail: brtchrise@aol.com

**Rural Law Enforcement Technology Center
(RULETC)**

1908 North Main Street
Suite 115
Hazard, KY 41701
(p) 866-787-2553
(f) 606-436-6758
E-mail: ruletc@aol.com

**Office of Law Enforcement Technology
Commercialization**

2001 Main Street
Suite 500
Wheeling, WV 26003
(p) 888-306-5382
(f) 304-231-2310
E-mail: oletc@oletc.org

Office of Law Enforcement Standards

100 Bureau Drive
Stop 8102
Gaithersburg, MD 20899-8102
(p) 301-975-2757
(f) 301-948-0978
E-mail: oles@nist.gov

Appendix K. About the Office of Law Enforcement Standards

The Office of Law Enforcement Standards (OLES) was established as a matrix management organization in 1971 through a Memorandum of Understanding between the U.S. Departments of Justice and Commerce based on the recommendations of the President's Commission on Crime. OLES' mission is to apply science and technology to the needs of the criminal justice community, including law enforcement, corrections, forensic science, and the fire service. While its major objective is to develop minimum performance standards, which are promulgated as voluntary national standards, OLES also undertakes studies leading to the publication of technical reports and user guides.

The areas of research investigated by OLES include clothing, communication systems, emergency equipment, investigative aids, protective equipment, security systems, vehicles, weapons, and analytical techniques and standard reference materials used by the forensic science community. The composition of OLES' projects varies depending on priorities of the criminal justice community at any given time and, as necessary, draws on the resources of the National Institute of Standards and Technology.

OLES assists law enforcement and criminal justice agencies in acquiring, on a cost-effective basis, the high-quality resources they need to do their jobs. To accomplish this, OLES:

- Develops methods for testing equipment performance and examining evidentiary materials.
- Develops standards for equipment and operating procedures.
- Develops standard reference materials.
- Performs other scientific and engineering research as required.

Since the program began in 1971, OLES has coordinated the development of nearly 200 standards, user guides, and advisory reports. Topics range from performance parameters of police patrol vehicles, to performance reports on various speed-measuring devices, to soft body armor testing, to analytical procedures for developing DNA profiles.

The application of technology to enhance the efficiency and effectiveness of the criminal justice community continues to increase. The proper adoption of the products resulting from emerging technologies and the assessment of equipment performance, systems, methodologies, etc., used by criminal justice practitioners constitute critical issues having safety and legal ramifications. The consequences of inadequate equipment performance or inadequate test methods can range from inconvenient to catastrophic. In addition, these deficiencies can adversely affect the general population when they increase public safety costs, preclude arrest, or result in evidence found to be inadmissible in court.

For more information on the National Institute of Justice, please contact:

National Criminal Justice Reference Service

Box 6000
Rockville, MD 20849-6000
800-851-3420
e-mail: askncjrs@ncjrs.org

To access the World Wide Web site, go to
<http://www.ncjrs.org>

If you have questions, call or e-mail NCJRS.