

# BODY ARMOR *for* FEMALE OFFICERS: WHAT'S NEXT?



*By Michele Coppola*

*Body armor for law enforcement and corrections officers should provide a balance of protection and comfort. For both men and women, if body armor does not fit correctly and provide adequate coverage, it can affect safety and effectiveness. Designing and building armor for female officers can present issues of particular concern.*

The National Institute of Justice (NIJ) is in the process of updating its standards for stab-resistant and ballistic-resistant body armor. How to ensure that female-designated models of body armor provide adequate protection is a primary concern for both the stab-resistant and ballistic-resistant standards revision efforts.

NIJ develops standards using Special Technical Committees (STCs), which bring together law enforcement or corrections practitioners and technical experts. Members of these committees are investigating how best to improve testing of body armor for women in the revised standards, as design of female-designated armor continues to evolve.



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Soft body armors designated as female differ from male and gender-neutral vests in that they can incorporate curved or shaped protective panels to accommodate the female bust. Flat male or gender-neutral models may be suitable for female officers with smaller busts. Depending on design and materials, they may not be suitable for those with larger busts, as the busts push the front armor panel forward, enlarging the underarm gap and therefore lessening the area of coverage between the front and rear panels.

Manufacturers have a variety of methods available to them to create bust cups, including cutting and stitching the material, or darting the material to form bust cups. When a ballistic-resistant female-designated armor model is tested, the laboratory is instructed to locate the seams or other areas of potential weakness that may be 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 formation of the bust shape does not introduce weaknesses into the vest, and that the shaped vest continues to provide the minimum level of protection required. Types and styles of female-designated vests vary, as do ways of fitting vests to accommodate the various sizes and shapes needed for female officers. Some manufacturers have developed methods which 'mold' the bust cups into the material, negating the need for cutting and stitching to create a bust cup. These armors are also subjected to additional testing to ensure that the molding process does not introduce vulnerabilities in the armor. (Adapted from [http://ojp.gov/bvpbasi/bvpfaqs\\_vestseligibility\\_15.htm](http://ojp.gov/bvpbasi/bvpfaqs_vestseligibility_15.htm).)

"The original test methods for body armor were designed around a flat torso, and obviously the female anatomy is different from that. Body armor designed for female officers incorporate unique seams and folds that aren't present in male body armor models. We would like to investigate the

role these differences play in determining the performance of a vest,” explains David Otterson, a materials engineer with NIJ’s National Law Enforcement and Corrections Technology Center (NLECTC), which administers the NIJ body armor Compliance Testing Program. At the request of NIJ, NLECTC began investigating how a test might be conducted for the bust area.

“Designing, manufacturing and testing female-specific body armors presents a complex technical challenge, for example, a material that works perfectly well as a flat armor may not perform well when subjected to folding, cutting, stitching or even changes in the stresses in the materials as it is shaped to provide protection,” says Daniel Longhurst, a mechanical engineer with NLECTC who is coordinating the effort to revise the NIJ stab-resistant and ballistic-resistant body armor standards.

“Additionally, there are comfort factors that impact the wearability of armor, and if an armor is uncomfortable, it is less likely to be worn, leaving the officer unprotected,” Longhurst adds. “For both ballistic- and stab-resistant armors, the STCs are investigating ways of accurately and consistently testing female armors. Once the baseline performance and test requirements are established, the armor industry will be able to focus their design efforts in providing safe and comfortable armors for female officers.”

Currently, female-designated ballistic-resistant armor is either tested flat or with clay built up behind the bust area of the armor. NLECTC staff have been researching and experimenting using alternative methods of supporting the female armor during both ballistic-resistant and stab-resistant testing as a possible way to better represent the female form. Staff have investigated

several possible materials including silicone; clay; foam; ballistic gelatin; and Perma-Gel™, which is a synthetic ballistic gelatin. Research is also being done on sizing criteria to define the appropriate size and shapes to possibly be used in testing; however, more research is needed.

“The existing testing methods can lead to inconsistencies in how laboratories prepare the female front armor panel for testing,” says Debra Stoe, NIJ standards policy advisor. “Depending on the size of the armor, sometimes armor is pressed flat or tested with clay built up in the bust area. Because of anatomical differences, we have specific areas of concern, but we don’t have data. We need to look at what is the short-term and long-term impact of being shot in the breast area.”

Data collection is needed to determine the differences in testing for female-designated armor among laboratories. Also, in ballistic-resistant armor testing, backface deformation





(BFD) is the measurement on the indent in a clay backing material when a bullet that does not penetrate a vest makes an impression on the clay. BFD testing of very small panels of armors, as well as whether the amount of allowed deformation should be different for the breast area, could be areas for study.

“Investigating the impact of ballistic backface deformation in the bust area is a research topic that has had limited research, and we are looking at existing research and exploring other areas, including the international armor research community, to try and leverage available funding to investigate this area further,” Longhurst says.

“I would like to see future research in this area to give a greater understanding of BFD on the bust area, specifically, what level of BFD injury must we protect against? Currently, depending on shot location, a BFD injury can be anything from reddening and bruising to lacerations and necrosis of tissue. By engaging with the international community and utilizing an advisory panel being established by Debra Stoe, we hope to be able to answer some of these questions and develop testing methodology that serves the needs and requirements of female armor wearers.”

Armor designated as female could be tested to male armor requirements to gauge baseline performance, with additional testing in the bust area to ensure confidence

that the armor continues to work in areas where it has been changed to accommodate the female form.

“The idea is to use a supplemental test technique to ensure that when rounds impact areas of the female anatomy that they have the same level of protection as existing male armors, but when striking the bust area, we want to make sure that we provide a more biofidelic test method that specifically addresses the unique female anatomy,” Otterson says.

Estimates of the number of female law enforcement officers in the U.S. vary between about 12 and 20 percent. In discussions, body armor issues expressed by some female officers include improper fit, riding up or shifting out of place, skin abrasions, bust cups too large and bust cups too small. For men and women, armor that is too long and rides up is a problem as well as armor that is too short. To protect the sides of the torso, the ballistic vest should be worn with the front panel overlapping the rear panel, and NIJ recommends an overlap of approximately two inches front to back.

“The coverage of armors is of key concern, and armor that is too small leaves areas such as the shoulder blade, armpit, sides and waistline vulnerable; armor that is too big is uncomfortable, rides up and could restrict access to an officer’s weapon,” Longhurst says. “We want to avoid both of these potentially life-threatening situations.”

Improvements have been made in body armor for women, but more needs to be done. The protection levels and test threats will be the same for armor for female officers as for male officers. The challenge is fit and testing.

“I think many times female officers are asked if they prefer male or gender-neutral vests and they said yes because they

don’t have female-designated armor that is comfortable and fits right,” Stoe says. “There are not enough female designs out there to address the need. A standard should be based on requirements, which are based on need, and the needs of the female officers in law enforcement are not being addressed sufficiently.”

In addition to the STC activity, NIJ has held workshops focused on concerns surrounding armor worn by female officers in an effort to identify issues that can be addressed in the short-term and issues that require long-term study. NIJ, in coordination with its sister agency the Bureau of Justice Assistance, is exploring forming an advisory panel to guide research, development, testing and standards for ballistic-resistant body armor worn by female officers. The advisory panel would include representatives of federal agencies and nonfederal organizations that can inform the process.

## **ASTM Body Armor Standards Efforts**

Body armor manufacturers do not measure wearers in the same way; much like clothing manufacturers, not all small or medium sizes are the same. ASTM International developed a standard that provides measurement guidance to assist in fitting ballistic-resistant body armor and stab-resistant body armor covering the torso. The aim of *ASTM E2902-12 Standard Practice for the Measurement of Body Armor Wearers*, published in 2012, is to facilitate consistency of



measurement across the body armor industry and help wearers understand proper measurement.

The document addresses measurements for concealable (normal duty) and tactical (special duty) armor for both male and female wearers. It does not address area of coverage (how much of the torso is covered by the vest). ASTM is working on other body-armor related standards, including a follow-up effort to the measurement standard to address measurement and fitting of body armor; body armor terminology; and a standard specification for the clay backing material used in ballistic-resistant armor testing.

“What ASTM is providing us with is an opportunity to breakdown the very complex body armor standard into separate test methods and components that will be looked at independently, and then NIJ will have the ability to pull these independent components together,” Stoe says. “The advantage of these smaller, separate test methods is that they can be adopted by a number of different standards, such as the Department of Defense or NIJ, but the process remains the same, and this results in developing better and more consistent testing practices within laboratories, resulting in more robust and repeatable body armor standards. The ASTM effort will have a huge impact.”

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