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## Technology Assessment

# National Institute of Justice

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## Law Enforcement Community Supports NIJ Body Armor Standard-0101.03

The National Institute of Justice, through its Technology Assessment Program Information Center (TAPIC), has received numerous calls from law enforcement agencies concerned with the recent issuance of the Personal Protective Armor Association's standard for body armor and Du Pont's proposed restrictions on the sale of Kevlar<sup>®</sup> to manufacturers who construct armor to comply with the NIJ standard.

Concerned with these issues, NIJ convened a special meeting of the Technology Assessment Program Weapons and Protective Systems Committee on August 28, 1989, to assist NIJ in developing a response to these actions. It was this committee of law enforcement practitioners, policymakers, and union representatives that originally recommended to NIJ the promulgation of a body armor standard that ensures that police receive the safest, most comfortable, armor that technology can offer.

The committee reviewed an analysis of the PPAA standard prepared by NIJ and agreed that the industry standard is less stringent and may place police officers' lives at risk needlessly. The committee was surprised that the PPAA had issued a new standard without the input and support of law enforcement and despite the endorsement the NIJ standard has received by police and leading organizations, such as the International Association of Chiefs of Police.

Committee members also discussed at length with Du Pont corporate executives

present at the meeting their concern with the preferential restrictions placed on the sale of Kevlar<sup>®</sup>. The restrictions that were to become effective on September 23, 1989, state that Du Pont will not sell Kevlar<sup>®</sup> to manufacturers for vests to be built to comply with NIJ's standard unless they agree to a heavier, more rigid construction specified by Du Pont.

At the unanimous urging of the committee, the Du Pont representatives agreed to suspend initiation of the Kevlar<sup>®</sup> sales restriction until December 31, 1989, and to provide scientific data supporting any modification to NIJ Standard 0101.03 for review.

This bulletin provides information on the NIJ standard, an overview of the PPAA standard, and a point-by-point determination of the significant differences between the two.

### Background

Representatives of the National Institute of Justice (NIJ) Technology Assessment

Program (TAP) and officially appointed members of the Personal Protective Armor Association (PPAA) met throughout a 6-month period ending in April 1987. During those meetings the government and industry accomplished three major objectives:

- NIJ Standard-0101.03, Ballistic Resistance of Police Body Armor, was formulated, the draft circulated to PPAA members, and the standard unanimously endorsed by the PPAA membership.
- Administrative procedures for the NIJ body armor compliance testing were drafted and agreed to by PPAA members.
- The PPAA membership agreed to participate voluntarily in an NIJ-funded compliance testing program.

The compliance testing program was an act of good faith on the part of NIJ, which felt obligated to absorb the cost of testing armor that manufacturers had previously

The Technology Assessment Program (TAP) is an applied research project of the National Institute of Justice (NIJ). TAP develops minimum performance standards for law enforcement equipment and tests equipment based on these standards.

The TAP Advisory Council comprises more than 50 nationally recognized criminal justice practitioners from Federal, State, and local agencies. Its purpose is to assess equipment needs and assist the program in setting priorities for the development of equipment standards and testing of commercially available products.

The TAP Information Center coordinates the Advisory Council's activities, selects certified laboratories to test equipment, oversees the testing process, and publishes the results of product testing.

tested at their expense for compliance with the now-obsolete NIJ Standard-0101.02. Because PPAA members listed 64 models previously tested and found to comply with the .02 standard, NIJ and PPAA both viewed the testing as a pro forma validation. Although there had been allegations of testing irregularities during .02 testing, NIJ believed that even if they were true, only isolated cases were involved at most.

When a new contractor for the operation of TAPIC was selected, an effort was made to correlate the stored .02 armor with the test reports. In many cases, no correlation was possible. A meeting was held with the president and two representatives of PPAA to discuss the problem. The only available solution, as agreed to by all parties, was to develop a new standard (.03) and retest all models previously passed under .02.

When the manufacturers' armor failed the .03 testing at an extremely high rate (approximately 60 percent), PPAA attacked the NIJ standard and compliance program. The PPAA membership was formally briefed on the results of the program (March 1988). Manufacturer claims of improper test procedures were refuted, and an analysis was presented indicating that many of the manufacturer models were either (1) of marginal design; (2) manufactured from marginal or ballistically substandard fabric; or (3) both.

The PPAA refused to accept the information provided and increased its attacks on the NIJ standard, first requesting that NIJ revert to the use of NIJ Standard-0101.02, then that NIJ rescind Standard-0101.03 and establish an entirely new standard. When the Department of Justice rejected the PPAA appeal because PPAA presented no technical data or substantive rationale justifying recall or modification of the NIJ standard (beyond the 60 percent failure rate of armor thought to comply with .02), PPAA elected to publish a standard of its own in June 1989.

Superficially, the PPAA standard appears to be a revision of NIJ Standard-0101.03, with added tutorial information. The PPAA acknowledgments appear to imply participation and universal endorsement by a number of private firms and government agencies, including NIJ.

#### Overview of the PPAA standard

The paraphrasing of the format and language of NIJ Standard-0101.03 gives the impression of an expanded revision of the NIJ document. Subtle but very significant changes have been made that could be missed easily in casual reading of the document.

The NIJ standard classifies six levels of protection, compared to five in the PPAA document. The NIJ type I classification has been deleted, and the PPAA level A appears roughly equivalent to the NIJ type II-A classification with respect to test rounds.

PPAA levels C and D are essentially the same as NIJ type III-A and III, and PPAA level E is equivalent to NIJ type IV.

The principal differences between the PPAA standard and the NIJ standard are the PPAA's attempts to lower the requirements—by averaging blunt trauma measurements, lowering the threat from all ammunition by spreading the velocities, allowing lower velocity passes, using test ammunition that deforms more easily, making waterproofing optional, and prescribing labels that not only do not list the ballistic threats but appear to place the liability for selection on the individual wearer or his or her department.

Technically, this "... toughest, most practical, personal body armor standard ever produced" serves to modify or eliminate many of those requirements and test methods of the NIJ standard that have been causes for failure of the PPAA manufacturers' armor—in spite of the fact that nearly all PPAA members now produce armor models that fully comply with the NIJ standard.

#### Point-by-point comparison

- a. The PPAA level B uses a broader velocity range for the 9mm test round than the NIJ standard (type II), which suggests that the .357 magnum test is higher than that of the NIJ standard (type II) by using a velocity range of  $1450 \pm 50$  fps vs. the NIJ requirement of  $1395 +50 -0$  fps. However, the .357 magnum round is a hollow-point round of significantly less weight (125 vs. 158 grains) than the NIJ .357 jacketed soft-point test round. The PPAA .357 round at a velocity of 1400 ft/sec yields 544 ft/lbs of energy, while that of the NIJ round is 687 ft/lbs, a difference of 143 ft/lbs. The PPAA round is a lesser threat with respect to blunt trauma protection than the NIJ test round.  
  
More than two-thirds of 45 type II armor models tested for compliance since the spring of 1988 and found not to comply with the requirements of the NIJ standard failed as a consequence of .357 magnum penetrations.
- b. The PPAA standard reduces the number of test rounds from six to five. During testing since the spring of 1988, approximately 30 percent of 40 panels of armor that failed to comply did so because of penetration on the sixth shot from .357 or .44 magnum ammunition, and approximately 38 percent from penetration by 9mm ammunition.
- c. The PPAA standard requires that the armor be smoothed after each impact. This effectively precludes the evaluation of armor protection from multiple impacts. The NIJ assumption is that an officer has no time to smooth the armor between impacts.
- d. The PPAA standard evaluates blunt trauma protection (deformation in clay backing) by taking the average depth of deformation of eight 0-degree incident impacts. This action ignores the maximum limit of 44mm deformation determined through medical laboratory research. Averaging the defor-

mation makes it permissible to exceed the maximum allowable by major amounts if other impacts are below limits. This presents a life-threatening risk to the officer wearing the armor. An additional factor entering into the blunt trauma measurement is that if the clay within the mannequin proposed by PPAA is still rounded, as was shown to NIJ initially, the blunt trauma measurements are in error because the measurements are taken from a plane that is below the correct baseline.

- e. The PPAA standard expands to three inches the allowable limit on the space between impacts from the NIJ-specified 2 inches, again less stringent than the NIJ requirement.
- f. The PPAA standard includes a test with 12 gauge 00 buckshot. Deformation is not measured. If, as NIJ has found, the deformation exceeds the allowable 44mm limit, the wearer *is not protected from this impact*.
- g. The PPAA standard makes tests of ballistic performance in the wet condition optional in the requirements section. Approximately 60 percent of 81 models of armor tested since the spring of 1988 that failed to comply with the NIJ standard did so because of penetration while wet. Current NIJ research agrees with previous work, confirming that the Kevlar® ballistic element can lose up to 40 percent of its strength when wet.

It is not clear from the PPAA standard who has the option to test in wet condition—the purchaser or the manufacturer.

- h. The PPAA standard uses the same test weapon muzzle to sample distance for handgun and rifle ammunition. This distance is probably too short to permit rifle bullets to stabilize. Projectiles that yaw and are unstable at the time of impact are easier to defeat.

- i. The PPAA standard increases the velocity tolerance from the NIJ requirement of +50 -0 feet per second to  $\pm 50$  feet per second. This allows armor to comply at 50 feet lower than the stated protection velocity.

The NIJ requirement, which first appeared in the .03 revision, was a direct consequence of the recommendation from PPAA representatives. NIJ accepted this recommendation because it permitted an unambiguous specification of the minimum level of protection by a given armor type. NIJ changed the velocity tolerance after considering the PPAA recommendation for two reasons: (1) the purchaser would know more precisely what protection his or her armor provided; and (2) it serves to clarify the manufacturer's liability.

The PPAA standard permits a chronograph error of  $\pm 0.5$  percent, compared to the NIJ requirement of  $2\mu$ s accuracy, which is  $\pm 0.01$  percent at rifle velocities. This is 50 times the allowable error in velocities.

- j. The PPAA standard makes the labeling of the armor strike face optional. This will require that all unmarked panels must be tested both ways to be sure that there is no difference in performance.
- k. The PPAA standard reserves the manufacturer's right to have user test results repeated in the case of a discrepancy between user and manufacturer (6.1). It does not clarify which test results ultimately govern or what recourse the user has if not satisfied.
- l. The PPAA standard (6.2) requires manufacturers to use the same methods of inspection on production materials as used for samples tested for compliance. If the manufacturer does not quality control material used for compliance testing, the standard does not require the manufacturer to do so for production material.

- m. The PPAA standard labeling requirements appear to place total liability upon the user rather than the manufacturer. (PPAA standard, pages B1-B3.)

- n. The PPAA standard limits the number of impacts upon the test sample to six. NIJ previously agreed to eight, at the request of the PPAA, in spite of the fact that an analysis of testing to the prior edition of the NIJ standard (0101.02) demonstrated that the majority of armor tested was subjected to a minimum of 12 impacts (six each of two types of ammunition). No questions were raised at that time as to the number of shots per sample. The limit is likely because a number of armors failed on the sixth shot during the original round of testing to .03. This change is considered to be an effort to reduce the number of failures.

- o. Sections 9.1 and 9.2 of the PPAA standard imply that PPAA will police its membership and take action if a product shows signs of poor workmanship or does not comply with labeling requirements.

Historically, PPAA has not taken this action. A case in point was in 1988 when NIJ corresponded with the PPAA president requesting that PPAA investigate the circumstances surrounding a specific procurement. It had been alleged that the manufacturer did not supply the armor for which it contracted in that procurement. This complaint was not responded to, and there is no evidence that PPAA made any attempt to investigate the allegation.

- p. The PPAA standard notes the necessity of using PPAA-approved testing laboratories, mannequin-holding fixtures, and depth gauges. It is not clear how this approval is obtained, what the approval procedures are, or what actions are taken to assure the technical competence of those responsible for approval action.

- q. Allowing the testing of unlabeled armor permits a possibility of abuse, because any number of additional samples can be tested after a failure, without penalty, until "compliance" is achieved.
- r. It is possible to qualify for compliance to the PPAA standard with as few as 22 shots if the wet test is omitted; the NIJ .03 Standard requires 48 shots on four sets of armor.

### Conclusions

In summary, it appears that the PPAA document places the armor wearer at risk needlessly. There is no need to downgrade the requirements. Most of the manufacturers have garments in compliance with 0101.03, and if they continue to manufacture the garments in the same way, the manufacturers should be able to provide suitable armor as long as the

quality of the incoming fabric they use remains constant. Law enforcement use of the PPAA document may place the wearer and his or her department in an area of liability that properly belongs with the armor manufacturers.

Most significantly, the existence of two armor standards for life-saving equipment makes the selection of equipment even more difficult than at present in this highly technical field.

### For further information

TAPIC has several publications available on police body armor, including the *Ballistic Resistance of Police Body Armor NIJ Standard-0101.03*, the *Selection and Application Guide to Police Body Armor*, and the *Police Body Armor Consumer Product List—4th edition*. Copies of these and other publications are available by calling or writing TAPIC at

1-800-248-2742 or 1-301-251-5060,  
1600 Research Boulevard, Rockville,  
MD 20850.

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