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Old Armor Tests as Good as New

Law enforcement officers protect the lives and property of citizens, and one piece of equipment is the primary protector of police: soft body armor made of KEVLAR® aramid fiber.

In response to many requests for information about the effect of age on the ballistic resistance of armor, NIJ has just completed a joint U.S.-Canadian test of old armor; the results indicate that the ballistic resistance of vests remains high even in vests more than 10 years old.

Age alone does not cause the ballistic resistance of armor to deteriorate. Rather, the kind of care and maintenance the garment receives is a more important factor.

This Alert summarizes the results of the NIJ tests of older armor; the full data are available from the TAP Information Center.

The Sample

To test older vests, NIJ was able to collect 24 vests that were issued by LEAA back in 1975. The vests came from five departments and two Federal agencies. Originally, LEAA issued 1,500 of this type of vest to 15 local law enforcement agencies and supplied fabric to two Federal agencies.

The sample of 24 contained 8 vests that had never been worn and 16 that showed various degrees of use. Of the 16 used vests, 4 showed light wear, 4 moderate wear, and 8 heavy wear. The front and back panels of each sample were labeled and tested individually. A total of 48 separate panels were tested.

All 24 vests were Threat Level I types, that is, armor that provides protection against .22 caliber and .38 caliber handguns.

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The Testing Procedure

The armor was tested at H.P. White Laboratories, a TAPIC approved, independent testing laboratory. A team from the TAP Information Center, the Law Enforcement Standards Laboratory (LESL) of the National Bureau of Standards, and the National Research Council of Canada's Office of Public Safety reviewed and verified the testing onsite.

The test personnel at H.P. White shot the panels with .22- and .38-caliber ammunition to correspond to the threat level of the vests. Half the vests were tested wet and half were tested dry.

The blunt trauma protection was measured according to NIJ Standard 0101.01. This is determined by the deformation the stopped bullet causes on the back side of the panel. The fabric in the panel is allowed to deform to a maximum depth of 1.73 inches.

To measure the ballistic performance, the V-50 of each panel was measured. V-50 is the median velocity of five shots that penetrate the armor and five that do not penetrate. V-50 testing is complicated, but it gives a sophisticated measurement of ballistic performance.

The V-50 testing was conducted according to the Military Standard Ballistic Test For Armor, MIL-STD-662D, March 19, 1984. (The NIJ Standard does not address V-50 testing.)

All unused vests were tested first and their average V-50 calculated. The used vests were then tested and their V-50 compared with the unused vests. The table of results presents the V-50 ballistic limits and the percentage each used vest varies from the average V-50 of unused vests. For example, the V-50 for sample 33F in the light wear category was 1104, 3.2 percent better than the average V-50 for unused vests.

Test Results

As the results in the table show, 10-year-old armor showed no significant deterioration.

All of the used armor that was shot with .38-caliber ammunition--light, moderate, and heavily worn vests--tested better than the average of unused vests. The heavily worn vests, in fact, had an average V-50 that was 4.7 percent better than the unused vests.

For armor that was shot with .22-caliber ammunition, the light and moderate wear armor also tested better than the unused armor. The average V-50 of the heavily worn vests was only 2.2 percent less than the average for unused vests.

The V-50 of two of the heavily worn vests (samples 6 and 9 on the table) was significantly lower than the others when tested in the wet condition. However, when retested dry, the V-50 returned to that of the other vests, indicating that the panels lacked sufficient waterproofing.

All vests tested satisfactory with regard to blunt trauma protection.

What the Tests Mean For Departments

Most departments cannot afford to needlessly replace all the vests they now have in service--and they may not need to. But they do need to begin developing a replacement policy that reflects how their armor is used and cared for and what kind of increased threat they may be facing.

Body armor is expensive. A vest typically costs between $150 and $300. But the medical bills for an injured officer may run as high as $500,000--enough money to equip 2,000 law enforcement officers with a bullet-resistant vest.

Procedures To Ensure Safe Armor

Assess the department's threat level.

Common sense suggests assessing the most common threat level facing the department's officers by reviewing confiscated weapons and the officers own service weapons. Older vests may not be suitable to meet current threat levels. When body armor first went into service, the most common handgun threat to police officers was from .22 long rifles and .38 special cartridges. (Thus the vests from 1975 were tested against this threat level.)

Police officers are now carrying more powerful weapons--and so are the criminals. In 1985, .38-caliber and .357 magnum revolvers were involved in more than half the deaths of officers. Body armor issued several years ago may not be adequate to meet today's higher threat level.

Conduct visual inspections.

Once a department's body armor is adequate to meet the threat level its officers face, the next best step a department can take is to conduct a visual inspection of their vests. Armor that no longer fits properly cannot protect as it should. Armor that looks suspect--discolored, dirty, with worn fibers--should be tested in accordance with current NIJ standards.

Educate officers about proper cleaning methods.

Departments also should be sure their officers are caring for their armor properly; they should follow the manufacturers cleaning instructions. In general, KEVLAR body armor can be hand washed in cold or warm water with mild detergent. It should not be bleached, starched, or washed at a commercial laundry. The vest should be rinsed thoroughly to remove all traces of soap and then hung to dry. It should **not** be hung in the sun or out of doors and should be stored flat without folding.

Encourage officers to wear their armor.

But more than anything else a department can do is encourage officers to wear their armor. **Armor can protect only when it is worn.**

Not only can body armor protect against bullets, but many stories abound about how armor saves lives in other ways. One Florida department requires officers to wear their vests routinely and credits vests with saving 10 percent of its officers from all types of situations, including weapons assaults and traffic accidents (by shielding officers from steering wheel injuries, for example).

In summary, a vest's level of protection should correspond to the department's threat level. Once the threat level is assessed and the protection level is adequate, departments should be sure vests fit properly, are cleaned properly, can pass a visual inspection, and, most important, that officers wear their vests.

(continued on back)

Results of V_{50} Ballistic Limit Tests For 10-year-old Vests Made of KEVLAR.®

(V_{50} expressed in feet per second)

Legend:

Tested wet.

All others tested dry.

.38-Caliber Projectile[a]

Unused Vests

Sample	V_{50}
1F	1074
1B	1075
23F	1036
24B	1050
4F	1088
4B	1095
Average	**1070**

Light Wear Vests

Sample	V_{50}	Percent of variation from average unused vest
33F	1104	+3.2
33B	1135	+6.1
12F	1126	+5.2
12B	1112	+3.9
Average	**1119**	**+4.6**

Moderate Wear Vests

Sample	V_{50}	Percent of variation from average unused vest
10F	1108	+3.6
10B	1165	+8.9
30F	1120	+4.7
30B	1118	+4.5
Average	**1128**	**+5.4**

Heavy Wear Vests

Sample	V_{50}	Percent of variation from average unused vest
17F	1153	+7.8
17B	1075	+0.5
31F	1131	+5.7
31B	1152[b]	+7.7
18F	1080	+0.9
18B	1074	+0.4
13F	1159[b]	+8.3
13B	1129[b]	+5.5
Average	**1119**	**+4.6**

[a]All tests conducted using 158 grain lead round nose projectile. [b]Eight shot V_{50} determination.

Note: An additional unused vest (sample 22) contained eight, rather than seven, layers of fabric. This vest was excluded from the analysis, but results are reported as follows: front— 1161 V_{50}, back—1193 V_{50}, tested wet.

.22-Caliber Projectile[a]

Unused Vests

Sample	V_{50}
2F	1179
2B	1203
25F	1200
25B	1217
3F	1169
3B	1164
26B[c]	1260
27F[c]	1210
Average	**1200**

Dry retest, not included in average

3F	1102
3B	1182

Light Wear Vests

Sample	V_{50}	Percent of variation from average unused vest
15F	1219	+1.6
15B	1267	+5.6
21F	1214	+1.2
21B	1239	+3.3
Average	**1235**	**+2.9**

Moderate Wear Vests

Sample	V_{50}	Percent of variation from average unused vest
32F	1238	+3.2
32B	1224	+2.0
7F	1183	−1.4
7B	1251	+4.3
Average	**1224**	**+2.0**

Heavy Wear Vests

Sample	V_{50}	Percent of variation from average unused vest
20F	1160	−3.3
20B	1172	−2.3
8F	1200	0
8B	1205	+0.4
9F	1183	−1.4
9B	1154	−3.8
6F	1182	−1.5
6B	1137[b]	−5.3
Average	**1174**	**−2.2**

Initial wet test, not included in average

9F	1183	−1.4
9B	1099	−8.4
6F	1075[b]	−10.4
6B	1145[b]	−4.6

[a]All tests conducted using 40 grain lead round nose projectile. [b]Eight shot V_{50} determination. [c]NIJ could not verify that the front and back panels were actually from the same vest. These two panels—samples 26 and 27—were therefore labeled separately.

NIJ's Commitment

NIJ, in conjunction with the Law Enforcement Standards Laboratory, issued the first minimum performance standards for body armor in 1972, and then in 1978 began testing armor through the Technology Assessment Program to determine if it met the ballistic resistance requirements of the standard.

Now available for more than 10 years, soft body armor made of KEVLAR has proven to be an exceptionally effective material for resisting bullets. But like all fiber, it is subject to deterioration.

NIJ is committed to continuing to examine the issue of when to replace body armor. A department's replacement policy should be based on as many objective facts as possible, and NIJ will continue to test armor and provide data that will help agencies make informed decisions.

To obtain futher details of the used armor testing or a copy of the latest NIJ standard for body armor, feel free to call the TAP Information Center at 800-24-TAPIC. (In Maryland and Metropolitan Washington, D.C., call 301-251-5060.)

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