Felt-based and felt-enhanced BALLISTIC ARMOR
ArmorFelt™ Technology

- Auburn University ballistic protection technology
- NonWoven manufacturing technique
- Improved ballistic protection at lighter weight
- Improved body trauma effects
- Improved flexibility
- Highly adaptable to numerous environments
ArmorFelt™ strengthens ballistic armor

- Softer, air permeable fabrics
- Lighter weight and increased protection
- Lower body trauma when used in back
  - Reductions of up to 25% Back Face Deformation (BFD)
- Defeats
  - Ranger SXT “Cop Killer Bullets”
  - Explosion fragments
ArmorFelt™ - What is it?

- A soft, air permeable, ballistic felt using Nonwoven Fabric technology formed in a proprietary way

- Consists of
  - Semi-Thermoplastics – Aramids Like Kevlar and Twaron
  - Thermoplastics – Polyethylenes Like Spectra and Dyneema

- Combines materials and forming processes in a unique way not utilized by any other kind of ballistic resistant technology

BEST USED WHEN TEAMED WITH TRADITIONAL WOVEN BALLISTIC FABRICS LIKE KEVLAR AND TWARON
Energy absorption in HPPE/aramid fiber blends*

- Radiated strain energy
  - Transferred by aramid and High Performance Polyethylenes (HPPE) beyond impact area

- Fibrillation of aramids
  - Fabric network integrity preserved by non-malleable character of aramid

- Phase change induced in the thermoplastic HPPE
  - Resulted in a 30% increase in performance over predicted force dissipation behavior

*Tests performed at DuPont labs, Wilmington, DE
Results from US Army Aberdeen Proving Grounds test

- .22 cal. 17 grain, fragment simulating projectile, steel

Parameters:
- Weight < 0.7 lbs/ft²
- Projectile speed > 425 m/sec (1400fps)

Nonwoven materials were superior to woven aramid and woven PBO

Historical development of nonwoven armor:
- Original Kevlar 29 = 1275 fps
- Original (1991) blend gave 1425 fps (HPPE, 2nd quality and Kevlar 29)

Test results 31 August – 1 September 2002
Ballistic Resistant Vests
with
ArmorFelt™ Technology

• Present Air Warrior vest
  – 36 layers, 850 denier KM2 Kevlar Style 705
  – One seam in center
  – $Weight = 27.2 \text{ oz/ft}^2$

• Plainsman design
  – 2 layers, 7.6 oz/yd$^2$
  ArmorFelt
  • 50% 1.5 denier K29 Kevlar
  • 50% 3.6 denier Spectra 1000
  – 38 layers, 750 denier Twaron CT, style 3512
  – 2 layers, 7.6 oz/yd$^2$
  ArmorFelt
  – $Weight = 25.3 \text{ oz/ft}^2$
## Ballistic Resistance

<table>
<thead>
<tr>
<th>Threat</th>
<th>Current Aviation Soft Body Armor Specification</th>
<th>SES-I/Plainsman 06</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 grain V50</td>
<td>3300 ± 75 ft/sec</td>
<td>3373 ± 47 ft/sec</td>
</tr>
<tr>
<td>4 grain V50</td>
<td>2700 ± 75 ft/sec</td>
<td>2901 ± 28.5 ft/sec</td>
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<tr>
<td>16 grain V50</td>
<td>2225 ± 75 ft/sec</td>
<td>2322 ± 75 ft/sec</td>
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<tr>
<td>64 grain V50</td>
<td>1825 ± 75 ft/sec</td>
<td>2024 ± 55 ft/sec</td>
</tr>
<tr>
<td>9 mm V50</td>
<td>No standard specified</td>
<td>1980 ± 55 ft/sec</td>
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<tr>
<td>9 mm V0</td>
<td>Minimum 1500 ft/sec</td>
<td>1517 ± 15.5 ft/sec</td>
</tr>
</tbody>
</table>

Independent testing completed at H.P White Test Labs, Streets MD May 2006
2003 testing performed at Aberdeen Proving Grounds

2004 and 2006 testing performed at H.P White, Independent Test Facility, Streets, MD
## PERFORMANCE COMPARISON

**Backface Deformation (mm)**

Impact impressions into Roma Plastilina #1 clay

<table>
<thead>
<tr>
<th>Shot sequence</th>
<th>Specification (Max)</th>
<th>TEST RESULTS 2006</th>
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</thead>
<tbody>
<tr>
<td>Shot 1</td>
<td>44</td>
<td>29</td>
</tr>
<tr>
<td>Shot 2</td>
<td>44</td>
<td>28</td>
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<tr>
<td>Shot 3</td>
<td>44</td>
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<td>Shot 4</td>
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<tr>
<td>Shot 6</td>
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<td>28</td>
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<tr>
<td>Average velocities ft/sec</td>
<td>1500 (Min)</td>
<td>1540</td>
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</table>

Independent testing completed at H.P White Test Labs, Streets MD May 2006
## Flexibility

<table>
<thead>
<tr>
<th>Sample</th>
<th>Description</th>
<th>Areal weight</th>
<th>Wt@6 ”</th>
<th>Drop@6”</th>
<th>Deflect@6”</th>
<th>Moment@6</th>
<th>Flex6</th>
<th>Wt@9 ”</th>
<th>Drop@9”</th>
<th>Deflect@9”</th>
<th>Moment@9</th>
<th>Flex9</th>
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<tbody>
<tr>
<td>Current</td>
<td>Transverse</td>
<td>1.700</td>
<td>0.850</td>
<td>26.500</td>
<td>0.338</td>
<td>0.425</td>
<td>0.794</td>
<td>1.275</td>
<td>23.500</td>
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<td>0.956</td>
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<td>Longitudinal</td>
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<td>Transverse</td>
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<td>1.567</td>
</tr>
</tbody>
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**Improved Flexibility**
US Marines Test Results

I.E.D.’s

2.2lbs/ft² sample, range 15 meters

- Nine fragments impacted the sample panel
  - No complete penetration.
  - 3 large (50-150 grain) fragments impacted the panel along with six smaller (50 grain or less) fragments.

- One of the large fragments, penetrated three ArmorFelt and 14 aramid layers
  - (out of 3 layers of ArmorFelt, 40 layers of Kevlar, 3 layers of ArmorFelt)

- No other large fragments, penetrated deeper than three ArmorFelt layer

- None of the fragments completely penetrated the armor.

12.02.2002
US Marines Test Results

I.E.D.’s (cont)

2.2lbs/ft² sample, range 5 meters

■ 22 fragments impacted the sample panel
  ■ 1 complete penetration.
  ■ 2 large (50-150 grain) fragments impacted the panel along with twenty smaller (50 grain or less) fragments

■ Only one of the two large fragments, completely penetrated the armor
  ■ (3 layers of ArmorFelt, 40 layers of Kevlar, 3 layers of ArmorFelt)

■ None of the smaller fragments penetrated the armor.
Tests performed at Quantico, VA

2 samples tested
- A) Identical to Plainsman
- B) Heavier than Plainsman

M-67 hand grenade
- One detonation each target from 4 feet range

Results
- A) No penetrations on Plainsman type
  - 22 hits by fragments
- B) 1 penetration on heavier type
  - 17 hits by fragments
Ballistic Felt Results - Reduced Weight and Better Protection

- Lighter
- More flexible
- More protective
- Less body trauma
- Highly adaptable
- Self evolving (New fibers are already anticipated)