New Titanium Add-On Armor Provides Enhanced Soldier Protection in a Lightweight Solution

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TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

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Agenda

• Who Is ARDEC
• ARDEC’s History of Rapid Response to Soldier Needs
• Transition to Titanium
• Titanium Solutions for Special Forces:
  – Success of Gunner Protection Kit (GPK)
  – Tactical Seat
• Increased Need for Force Protection
  – Modular Advanced Composite Armor Kits
  – Next Up: Modular Crew Compartment for NSCV
• Summary
Providing the lethality technology for over 90% of the Army’s munitions

- ARDEC (all sites) ~ 3098 employees
  - Picatinny Arsenal = 2648
  - Benet (Watervliet Arsenal) = 240
  - Rock Island Arsenal = 145
  - Adelphi & APG = 65
- S&E average 20 years experience – more than 30,000 man-years of highly specialized experience in critical multidisciplinary fields (no commercial equivalent)
- S&E new hires from Apr 99 to Jan 07 = 994
- Intellectual Property (FY07):
  - Invention Disclosures – 49
  - Patent Applications – 30
  - Patents Issued – 13
- Patent License Agreements = 13
- Growth and success through Cooperative Research and Development Agreements (CRADA) = 159
- World recognized armaments authority
ARDEC’s Mission: Total Warfighter Support

Research & Development
- Electro Magnetic Gun
- CROWS Lightning
- Excalibur
- XM25 Grenade Launcher
- Lightweight Handheld Mortar Ballistic Computer

Demilitarization
- Lightweight Dismounted Mortar
- M240B 7.62MM Machine Gun
- M900 Armor Piercing Cartridge

SUPPORT TOTAL LIFE CYCLE
- Field Support
- 40mm Multi-Shot Launcher
- Gunner Protection Kits
- Small/Cannon Caliber Ammunition
- Advanced Crew Served Weapon

Production
- M777A2 Lightweight 155mm Howitzer
- M110 Semi-Automatic Sniper System

Technology Driven. Warfighter Focused.
Supporting GWOT: A History of Gunner Protection

2005: Stryker Cupola Shield

Fielded: Over 600 kits
Platform: Stryker, ASV Knight

2006: Objective Gunner Protection Kit (O-GPK)

Fielded: Over 30,000 kits
Platform: Humvee, MRAP

Army Top 10 Invention of 2007

2006: Picatinny Blast Shield (PBS)

Fielded: Over 250 kits
Platform: USMC LAV

Army Top 10 Invention of 2007

2007: RG31 O-GPK

Fielded: Over 327 kits
Platform: RG-31

2007: SOCOM O-GPK

Fielded: Over 200 kits
Platform: Humvee

2008: O-GPK Enhancements

Fielded: 20,000 planned
Platform: Humvee, MRAP

Need updated numbers
• The Stryker Cupola Shield ushered in a new era of opportunity for using titanium on US Army vehicles
• Weight, not cost, was the driving factor in choosing titanium
• Since the Bradley Hatch and M777, ARDEC has done significant technology work to make titanium more applicable and affordable

Courtesy of National Energy Technology Laboratory (NETL)
Titanium Makes Sense for the US Armed Forces

- Meets weight requirements for transportability
  - Up to 30% lighter than steel in ballistic applications
- Superior protection improves survivability
  - Good multi-hit capability and performance across wide range of ballistic threats
- Titanium components enable adding other capabilities without increasing overall vehicle weight
- ARDEC has a proven track record of titanium innovations and advancements
  - Improved melting and furnace technologies
  - Innovative welding technology advancements
  - Advanced, production-ready manufacturing and cost-reduction processes
  - Funded multiple extraction alternatives to the Kroll process
USASOC Requirements Drive Titanium GPK Development

- In January 2007 USASOC had urgent request for customized SOCOM GPK to meet additional Special Operations Forces (SOF) needs
  - Weight reduction
  - Secondary weapons
  - Additional transparent armor
- Titanium was determined to be the most effective material to meet performance and weight goals
  - Goal: turret and shield not to exceed 400 lbs
  - Approximately half the weight of standard O-GPKs
- ARDEC completed USASOC titanium GPK design in February 2008
- To date, over 125 titanium GPKs have been delivered (MORE?)
GPK Success Spurs Additional Titanium Armor Needs

- In September 2008, ARDEC was asked to develop a prototype tactical seat for the SOCOM Humvee Ground Maneuver Vehicle (GMV) that provides:
  - Increased ballistic protection for driver and passengers
  - Increased ergonomics
  - Long-term producibility and availability
- SOCOM wanted to reduce both the per-seat cost as well as the production time
  - Previously procuring aircraft seats made from composite materials
  - Limited quantities available, at higher cost
- Tactical seat leverages the design, material technologies, and processes developed for the SOCOM GPK
Titanium Seat Design Improvements

- Material: half-inch titanium ballistic plate
- Universal seat was designed to fit in all four locations on GMV
  - Passenger side front seat includes a bracket to increase leg room beyond current bolt pattern of GMV
- Design modifications provide enhanced ergonomics
  - Seat sides cutouts allow for seat belt clearance
  - Seat cutouts allows fire suppression system
  - Seat sides minimized to increase space around leg area
ARDEC developed a lean, production-ready manufacturing process to reduce the per-seat cost by 33%:
- Leveraged prior titanium armor design and manufacturing process successes
- Easily transferrable to the industrial base

**Tactical Seat Fabrication Process**

1. Water jet cutting
   - Seat bottoms and backs are water jet cut from titanium sheet, approximately 10 sets per sheet
2. Machining
   - Notches in seat bottom and holes for installation on various HMMWVs are machined into the seat
3. Bending
   - Seat backs are warmed up on an induction heater to 900 degrees
   - Seat backs are bent 23 degrees (accurate within half a degree)

4. Welding
   - Seat bottoms and backs are spot-welded, then MIG welded using:
     • Titanium welding wire (Ti-6Al-4V) deposited at 600 inches-per-minute
       - Double-pulse waveform allows “one droplet per pulse”
     • Water-cooled torch (Fronius) with helium trailing shield for splatter-free welds
   • Tactical seats are finished and installed at Letterkenny Army Depot (LEAD)
Results

- Initial prototype produced and delivered in less than 1 week
- The first 264 seats were delivered to Afghanistan and Iraq in June 2009
  - Lead time for titanium delivery 6 months
  - Production actually began in March 2009, making delivery time only 3 months
  - **XXX** weeks of production time saved due to lean manufacturing process developed
- Per-seat costs reduced by one third
  - From $6K to $4K
- SOCOM requested another 264 seats in June 2009
  - Production began in July 2009
Warfighter Payoff

• Increased ballistic protection
  – Warfighters sitting in the SOCOM vehicles will be enveloped in life-saving armor with enhanced ballistic protection

• Automated and mature manufacturing processes that enabled:
  – Significantly lower costs than the current COTS solution
  – Rapid, accelerated delivery to the warfighter, ensuring long-term producibility and availability

• Lighter weight using advanced materials for increased mobility
  – Reduce the overall weight of the seat

• Bottom line: increased survivability for SOF warfighters
Increased Force Protection Needs

- Better 360-degree protection is needed on lighter weight vehicles due to ever-dynamic and advancing threats in theater.
- The Army is looking to further reduce weight and increase protection for SOF warfighters by up-armoring civilian vehicles:
  - Outfit non-standard civilian vehicles with lighter weight materials.
  - Reduced weight leads to better performance and prolonged vehicle life.
Modular Advanced Composite Armor (MACA) Kits for Non-Standard Civilian Vehicles (NSCV)

- Provides immediate increase in protection level for NSCVs
  - Lighter weight than current ballistic steel armor and composites currently used to up-armor light vehicles
  - Reduced weight leads to better performance and prolonged vehicle life
- Materials: Dyneema, high-hard steel, transparent ballistic armor
- Modular design and fit
  - Easily installed and repaired in the field by non-technical personnel
  - No major modification to vehicle or exterior appearance when kit is installed
Titanium Can Make It Better

- Titanium Protective Crew Compartment could replace stock crew cabin for Special Ops trucks and NSCVs
  - Design to integrate into NSCVs
- Titanium would add structural strength and threat protection while reducing overall vehicle weight and maintaining vehicle agility
- Titanium and composite armor construction could withstand high-velocity armor-piercing (AP) ballistic and blast fragment threats and provide multi-hit protection

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.
• Titanium is a key material to meet the US Army’s goal of a highly survivable force
• Titanium Tactical Seat satisfied SOCOM’s requirements for weight and protection
• Material analysis of titanium allowed ARDEC to reduce the production time and cost
• Manufacturing technology advances help lower cost & make titanium more readily available to weapons systems
• ARDEC already working on next force protection system: Titanium Crew Compartment
Question To The Industry:

“When can we provide more military-grade titanium for the ‘big’ Army?”
ARDEC Titanium Successes
Stryker Cupola Shield

- Stryker Fire Support Vehicles (FSV) and Recon Vehicles (RV) lacked vehicle commander protection
- ARDEC leveraged titanium technologies to design/prototype cupola shield for high-rate production
- 400 kits delivered to OIF field units (March 2005)
- Titanium-based shield enhances survivability while improving operation and performance
Gunner Protection Kits (O-GPKs)

- ARDEC rapidly developed/fielded enhanced protective solutions for combat vehicles with transparent armor
  - ARDEC engineers and FAST team determined requirements Dec 2005

- Built on prior successes in rapid development and delivery
  - Designed concurrent with manufacturing engineering to speed development and fielding
  - Prototyped in-house using production-ready processes
  - Delivered for testing Jan 2006
Gunner Protection Kits

• Verified and tested by ARDEC, Aberdeen, PM-TV, TARDEC
• LRIP to OIF: initial 1,000 in Jul 2006
• Army depot production — 15,000+ O-GPKs for M1114
• New standard O-GPK meets warfighter force protection needs
• Awarded Army’s Top Ten Greatest Inventions for 2007

6 months from concept to production

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.
• Awarded Army’s Top Ten Greatest Inventions for 2007
• ARDEC-developed low-weight blast shields give vehicle commander enhanced protection
  – Positioned and angled for maximum IED blast deflection
• Minimizes weight and components to meet turret weight requirements
• Uses existing attachment points, proven ballistic materials and common manufacturing processes
• Installs in 30 minutes with no special tools
  – Modular kits proven producible and affordable with government-owned Technical Data Package (TDP)
• Rapidly integrated O-GPK onto RG-31 platform
• Provides 360° visibility and protection from common threats
• Enhanced protection and visibility for engineering units
• Works with modified Platt Systems 660mm ring mount
• Uses Army-supplied weapons and mounts
  • Mk-93 cradle, M2, Mk-19, M240B, M249
• ARDEC managed production of O-GPK kits and ring mount procurement
• Delivered initial units to Balad, Iraq early 2007
Overhead Protective Cover

- “Bolt-on” capability to existing turret shield includes concealment and ballistic protection from overhead attacks or elevated sniper threats
- Universal design ensures adaptability to multiple vehicle platforms
  - HMMWV, RG-31, RG-33, MRAP
- Advanced materials ensure weight can meet user requirements