New Titanium Crew Cab Provides Enhanced Soldier Protection

TITANIUM 2010  October 5, 2010

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Stephen Luckowski
Chief, Materials, Manufacturing and Prototype Technology Division
Chairman, American Welding Society - Structural Titanium Welding Code

Delfin Joe Quijano
Project Engineer, Materials, Manufacturing and Prototype Technology Division
• Who Is ARDEC
• ARDEC’s History of Rapid Response to Soldier Needs
• Warfighter Protection – Solutions for Special Forces:
  – Titanium Tactical Seat
  – Modular Advanced Composite Armor Kits
• Increased Need for Force Protection
  – Modular Crew Compartment for Commercial Vehicles
• Summary
Who Is ARDEC?

Providing the lethality technology for over 90% of the Army’s munitions

- ARDEC (all sites) ~ 3321 employees
  - Picatinny Arsenal = 2880
  - Benet (Watervliet Arsenal) = 239
  - Rock Island Arsenal = 144
  - Adelphi & APG = 58
- New hires since FY99 = 1191
- S&E average 20 years experience – more than 30,000 man-years of highly specialized experience in critical multi-disciplinary fields (no commercial equivalent)
- Intellectual Property (Q408):
  - Invention Disclosures – 58
  - Patent Applications – 164
  - Patents Issued – 11
- Patent License Agreements = 14
- Growth and success through Cooperative Research and Development Agreements (CRADA) = 121
- World recognized armaments authority
ARDEC Mission:
Total Warfighter Support

Research & Development

M240B 7.62MM Machine Gun

Demilitarization

Lightweight Dismounted Mortar

Production

CROWS Lightning

Field Support

Excalibur

TOTAL LIFECYCLE SUPPORT

XM25 Grenade Launcher

Lightweight Handheld Mortar Ballistic Computer

M777A2 Lightweight 155mm Howitzer

M110 Semi-Automatic Sniper System

Small/Cannon Caliber Ammunition

Advanced Crew Served Weapon

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.
Supporting GWOT: A History of Gunner Protection

2005: Stryker Cupola Shield
- Fielded: over 500 kits
- Platform: Stryker, ASV Knight

2006: Objective Gunner Protection Kit (O-GPK)
- Fielded: over 40,000 kits
- Platform: HMMWV, MRAP, HEMTT

2006: Picatinny Blast Shield (PBS)
- Fielded: over 400 kits
- Platform: USMC LAV

2007: USASOC GPK
- Fielded: over 400 kits
- Platform: HMMWV

2007: Abrams Shields/Hardware
- Fielded: over 1,600 kits
- Platform: Abrams

2008: Overhead Cover for O-GPK
- Planned: 20,000
- Fielded: over 3,000
- Platform: HMMWV, MRAP

Army Top 10 Invention of 2007

Army Top 10 Invention of 2008

Technology Driven. Warfighter Focused.
Titanium Warfighter Protection Makes Sense for US Armed Forces

- Performance is the driving factor in choosing titanium –
  - Meets weight requirements for transportability
  - Superior protection improves survivability across wide range of threats

- Titanium components enable adding other capabilities without increasing overall vehicle weight

- ARDEC has a long history of titanium innovations and advancements, making it more applicable and affordable
  - 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
• Early vehicle protection made use of titanium for very specific warfighter solutions (e.g., Stryker Cupola Shield)
• Early successes with Stryker solution led to the development of a special SOCOM version of a Gunner Protection Kit (O-GPK), including an all-titanium version for USASOC
• As protection needs continued to evolve to meet new threats, SOCOM sought both titanium Tactical Seats for GMVs and bolt-on under vehicle solution to help mitigate blast threats
In September 2008, ARDEC was asked to develop a prototype tactical seat for the SOCOM HMMWV Ground Maneuver Vehicle (GMV).

- Lighter weight solution used half-inch titanium ballistic plate for:
  - Increased ballistic protection for driver and passengers
  - Increased ergonomics and mobility

As of September 2010, ARDEC has delivered 714 seats to Afghanistan and Iraq.

- Universal seat was designed to fit in all four locations on GMV
- Per-seat costs reduced by one third
• Special Forces needs also included concurrent development of vehicle protection for non-standard civilian vehicles (NSCVs)

• Modular Advanced Composite Armor (MACA) featured kits that could be installed to protect the entire crew while maintaining vehicle anonymity
• 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 vehicle or exterior appearance modification needed when kit is installed
The Evolution of Warfighter Protection –
the Protective Crew Compartment

• As threats continue to advance and change in theater, a vehicle protection solution that meets these greater needs combines the light weight advantages of titanium and composites with the modular, complete crew protection qualities of the MACA kits

• A titanium, vehicle-mounted, configurable Protective Crew Compartment (PCC) addresses joint operational needs for better protection on lighter weight vehicles

• The PCC is a complete crew cab solution providing 360-degree protection with lightweight maneuverability and transportability
The Evolution of Warfighter Protection – the Protective Crew Compartment

- A titanium PCC reduces weight and increases protection for warfighters by up-armoring civilian/commercial vehicles
  - Better performance and prolonged vehicle life
- Titanium PCC could replace stock crew cabin for commercial trucks
  - Designed to easily integrate into CVs
- Titanium adds structural strength while maintaining vehicle agility
- Titanium and composite armor construction withstands high-velocity armor-piercing (AP) ballistic and blast fragment threats and provides multi-hit protection
Protective Crew Compartment Capabilities

- **PCC Crew Protection**
  - 360-degree kinetic and rollover protection
  - 360-degree battle space visibility (i.e., crew visibility)
  - Crew compartment fire suppression
  - Compartment ingress/egress

- **PCC Vehicle Integration**
  - Maintains external appearance of unmodified commercial vehicle
  - Uses COTS drive train and suspension and commercially supportable
  - Speed, maneuverability, complex terrain agility comparable to standard trucks
  - 350-mile operating range
  - Air transportable

- **PCC Mission support**
  - Payload to support multi-day crew sustainment
  - Crew size (four)
  - Adaptable weapons mount in truck bed
Protective Crew Compartment – Possible Implementations

COTS Vehicle
- COTS diesel engine and AWD driveline
- High mobility on and off road

Titanium Protective Crew Compartment (PCC)
- Integral crew protection for mine blast/ballistic threats
- Space for crew of four
- Low-cost titanium monocoque structure and armor
- Spall liner
- Transparent armor windows
- Energy absorbing seats
- Fire suppression system

Base PCC Vehicle
- Civilian vehicle appearance
- Protective Crew Compartment
- Air-transportable

Blast and Ballistic Protection Add-on Components
- Mission-configurable lightweight armor
- Improved mine blast and ballistic protection
- Excellent multi-hit capability

PCC High Survivability Mission Configuration
- Added ballistic and mine blast protection
- Civilian vehicle appearance
- Air-transportable

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.
Fabrication of the first prototype began in July 2010 at ARDEC Prototype Integration Facility (PIF) at Picatinny Arsenal.

Anticipated completion of the Protective Crew Compartment (PCC) prototype is end of November.

Integration of add-on armor material and testing is planned for January of 2011.
ARDEC developed a lean, production-ready manufacturing process to develop the prototype

- Leveraged prior titanium armor design and manufacturing process successes
- Easily transferrable to the industrial base

**PCC Fabrication Process**

1. Water jet cutting
   - Components, including doors and panels, are water jet cut from titanium sheet of varying sizes (from ¼” – ¾“)

2. Machining
   - Weld prep machining using chamfer tooling
3. Bending
   - Majority of components will be heated to by an induction heater to 900 degrees
   - Bending angles up to 40 degrees

4. Welding
   - GMAW-P welding process will be used:
     • Titanium welding wire (Ti-6Al-4V) – wire feed speed – at 600 inches-per-minute
       - Customized waveform allows “one droplet per pulse”
     • Water-cooled torch (Fronius) with helium trailing shield for splatter-free welds
Titanium is a key material to meet the US Army’s goal of a highly survivable force.

Titanium provides configurable, lightweight, survivable combat ground vehicle capability and transportability.

Titanium Protective Crew Compartment (PCC) evolved out of warfighter needs for greater protection against multiple threats.

Modular PCC provides optimum protection and visibility while maintaining unmodified appearance of commercial vehicle.