LIGHTWEIGHT & ADVANCED MATERIALS FOR DEFENSE
Materials for Military Ground Vehicles

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**Material for Military Ground Vehicles**

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**Video mentioned in Brief is not included, The original document contains color images.**
Outline

Tactical Vehicles
FCS Structure and Materials
Advanced Reconfigurable Structure
Materials for Tactical Trucks

Material must be readily available and fully developed.
- RHA
- High hard steel
- Aluminum

Research projects are ongoing to further develop advanced lightweight armors.
- Composites
- Ceramics
- Titanium

Long Term Armor Strategy
- A + B design
- Requirements are classified
FCS requirements

C130 transportable

- Transport weight not to exceed 18.5 tons
- Weight can be increased on ground
- Dimensional constraints
- Structure “A” + Armor “B” solution
- Structure selected by IPT to be 5059 Aluminum with friction stir welded 2195 Aluminum/Lithium belly
  - Fall back position 5083 Aluminum with friction stir welded 2195 Aluminum/Lithium belly
  - Fall back position 5059 complete structure
- No selection yet for “B” armor

Cost
Emergency transport configuration

Maximum Size Envelope For Variants

- 119" Width
- 108" Height
- 263" Hull Length (excluding barrel overhang)

Unlimited time for ECC - FCC transition

C-130 ramp hinge limit

Use Non-Combat Configuration (NCC) approach for vehicle configuration

Use platform maintenance manuals as the guide for removal and reassembly

Shoring is allowed to solve rail and hinge issues

This initial guidance will be refined and updated if required NLT Jun 16
This trade was conducted in accordance with the approved FCS trade study process.

The measures in the metallic material trade process will addressed:

- **Cost** - measured in dollars
  - Raw Material, measured in dollars per kilogram
- **Integration Burdens & Allocations**
  - Weight, measured in kilograms
- **Risk**
  - Producibility
  - Performance
  - New Material Characterization Cost
- **Performance**
  - Logistics
  - Corrosion Susceptibility
  - Mine Blast Resistance

*The IPT established weighting factors as part of the formal trade process.*
Assumptions (1)

- Trade is for metallic portion of MGV chassis only
- Trade Alternatives are:
  - Aluminum 2519
  - Aluminum 5083
  - Aluminum 5059
  - Aluminum 2519 with 2195 Al/Li friction Stir Welded Floor
  - Aluminum 5083 with 2195 Al/Li friction Stir Welded Floor
  - Aluminum 5059 with 2195 Al/Li friction Stir Welded Floor
  - Aluminum 2519 with Ti Bolt in Floor
  - Aluminum 5083 with Ti Bolt in Floor
  - Aluminum 5059 with Ti Bolt in Floor
- Trade will evaluate a MGV point design (BTA1U with updates)
- Initial MGV configuration will be Carrier type vehicle (C2V) Initial study will be for an “A” + “B” armor integration approach where upper hull “A” has no ballistic requirement at ECC and lower side wall will work in concert with Skirt, minimum thickness to be 0.75 Al and a 4 mm. allowable deflection from lower side wall to the suspension.
Hull Aluminum Material Trade Study
Results and Hull IPT Recommendations

Trade study results
- Aluminum hull material trade study winning candidates
  - 5059/2195 - Winner
  - 5083/2195 – Close 2nd
  - 5059 - Close 3rd
- Winning triad rankings robust and not susceptible to moderate weighting alterations
- High degree of Hull IPT consensus

Hull IPT Development Plan Approach
- Baseline hull material – 5059 hull / 2195 belly plate
- Risk fall back alternate plan A – based on possibility that hybrid belly plate technology may not mature prior to PDR
  - Fall back construction #A1- 5059 hull and belly plate
  - Fall back construction #A2- 5059 hull and titanium belly plate
- Risk fall back alternate plan B – based on possibility that 5059 may not mature prior to PDR
  - Fall back construction #B1- 5083 hull / 2195 belly plate
  - Fall back construction #B2- 5083 hull and titanium belly plate
**Risk Mitigation**

**Key Milestones**

- **SFR**
- **PDR (CM 0)**
- **SOS PDR**

**Test Assets**

- **X 12 BAE**
  - Incorporates AA5059 fusion welded to AA5083
  - **Dynamic Buck GDLS**
  - **ATR GDLS**
  - **FTR GDLS**
  - **X5 GDLS BAE**
  - **X6 GDLS BAE**

**Development Activities**

- **ARL 5059 FCT IPT**
  - Corrosion / Ballistic performance / weld performance / MIL-SPEC DEV
  - **BAE**
    - 5059 Fusion weld procedure qualification
    - **MTO BAE**
      - Fabrication of (14) welded test coupons to support FCT
      - **MTO BAE EWI**
        - Exploration of advanced joining technologies to the X12 design
      - **MTO GDLS EWI CTC**
        - Dissimilar Alloy Joining / Friction Stir Welding
          - **GDLS**
            - CM2 / X4F / Sub Scale Tubs / Panels

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**Superior Technology for a Superior Army**
Advantages of Structural Approaches

Space Frame
- Lightest “structure only” weight
- Tailorable survivability
  - Ballistic armor tailored to mission requirements
  - Low burden integration of EMA, Signature Management, Etc.
- Ease of repair
- Improved transportability

Monocoque
- Lightest weight approach assuming a base level of ballistic protection
- Efficient integrated structural armor solutions
- Maximum interior volume
- Lowest cost

Hybrid Structures
Leverages IHS concept to provide a full-scale hull survivability test bed
Composite HMG/Frag upper hull
Metallic lower hull with integral Medium Cannon front and ballistic armor skirts
Aluminum space frame aft section provides easy installation of modular armor for evaluation
EMA “integration” demonstrated
- Enough power and energy storage on board to accommodate applique
- Structural “sockets” or access points are designed in

**Monocoque Forward Section**

**Space Frame Aft Section**

**Government Testing**
Selected Space Frame Structure

**Features**
- Full space frame design
- High strength frame
- Composite upper and lower shells for EMI/Environmental
- Base armor mounts to frame
- Add-on armor/survivability kits mount over base armor
Forces, moments and displacements are extracted from the global model and applied as boundary conditions for local model.

**Little or no redundancy**: Sponson framing not required for mobility or gun firing; supplied as practical structure for mounting.
AX-0 Test Section Components

Frame Assembly
Composite Upper Skin
Armor Module

Completed January 2005
**Features**

- Multiple tube and node configurations
- Structural testing at Univ. of Del.-Center for Composite Materials
- Mobility load case
- Gun firing load case
- FE Analysis Correlation
- Ballistic shock evaluation at ARL-Aberdeen
Left Side – Armor suite and skins remove or set aside for ASC show

Right Side – Armor suite and skins attach for ASC show